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CONTENTS OF THIS NUMBER

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Prolonging the life of forging dies twenty fold is an achievement that will arouse the interest of all mechanical men. The leading article in the May number of MACHINERY tells how this is accomplished.

April Machinery

Small Tools

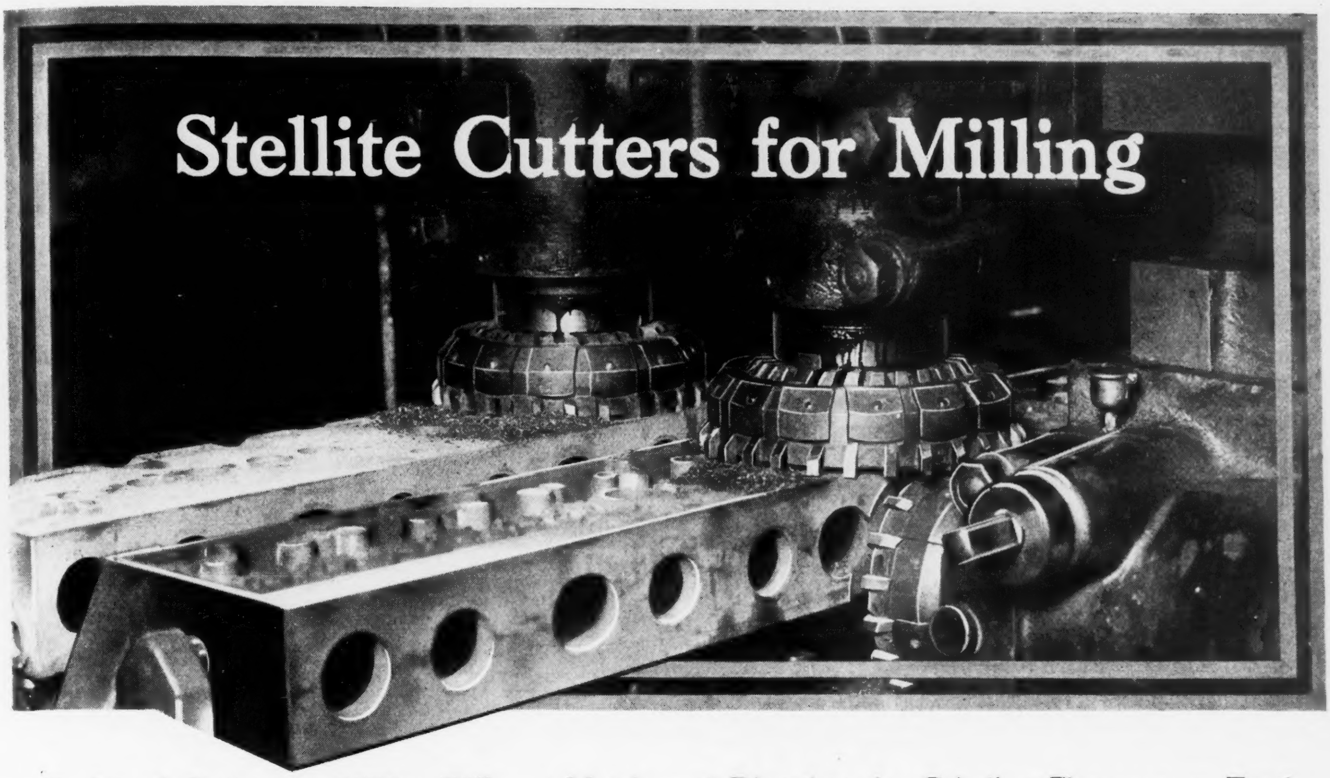
Small Tools are indispensable for both machine and hand processes. The big machine tool is just so much steel and iron without a sturdy cutter and a substantial work-holding device through which the power of the machine can be utilized. The hand work which always has been and always will be necessary, even in the most highly developed manufacturing operations, can't be done without small tools. The small tool is in a constant state of evolution. It is natural that developments take place in it more frequently than in the building of machines or machine tools because of the enormous number that are used up and replaced each year.

Every man in the metal working trades buys tools, owns tools or uses tools—every reader will be interested in this Small Tool Number of MACHINERY. It contains much original information pertaining to the making and use of small tools of many kinds. For example, there's an editorial article on the use of stellite for milling cutters and by happy chance there's an advertisement in the Small Tools Advertising Section which shows exactly how one concern welds stellite to machine steel shanks; both are valuable contributions to the fund of knowledge concerning the use of this alloy.

Nothing Can Be Done Without Small Tools

The Small Tool advertisements in this number give the reader real facts to work with—back the claims they make with figures and proofs. You'll find a lot of *"meat"* in them. The Small Tool Advertising Section featured this month will be continued in May MACHINERY; a number of manufacturers have already made reservations for announcements that couldn't be gotten ready in time to catch this number.

Two Numbers of



Stellite Cutters for Milling

Design of Cutters for Milling Different Metals, and Directions for Grinding Clearance on Teeth

By C. W. METZGER, Haynes-Stellite Co., New York City

THE removal of metal in the shortest possible time by milling requires a sturdy machine in good condition and cutters correctly ground. Cutter grinding is an art in itself. The condition of the tool grinder is of just as great importance as the condition of the milling machine; and the location of the stops and the position of the tooth-rests are equally important. Stellite milling cutters are made in both the solid type and the inserted-tooth type. The inserted-tooth cutter has by far the wider application at present. The best results are obtained with either type when the teeth are fairly closely spaced, so that the cutting edges may be passed over the work rapidly, each taking a light cut.

Tooth Shape for Solid Stellite Milling Cutters

In the history of solid milling cutters, there have been many changes in tooth shape. Tables of clearance angles, profiles, number of teeth, etc. for milling cutters are given in engineering handbooks but these refer to carbon and high-speed steel practice only; and there is no standard for these values that is universally agreed upon. The usual type of top-rake or hook-tooth solid milling cutter, the profile of which is shown at the left in Fig. 1, has a great deal of chip space, obtained by using a coarse pitch. A top-rake tooth is not needed for solid stellite milling cutters except on very tough materials; the radial-tooth cutter shown at the right, having more teeth per surface covered, is preferred for taking light chips at high speed—the condition of greatest efficiency when using stellite cutters.

Let us consider the effect of top rake on the coarse-pitch tooth high-speed steel cutter, commonly termed "heavy-duty." This cutter permits of greater feeds, but in gaining some advantage in that respect, the extreme cutting edge projects so far from the body that it becomes necessary to draw the temper of the teeth considerably to obtain sufficient toughness. This means loss of durability when run at high speed. In the case of the coarse-pitch heavy-duty cutter, practically only one tooth is engaged at a time, as may be seen in Fig. 1. As the advanced tooth leaves the cut, it suddenly places an additional load on the second tooth, which has only just penetrated the work and started its chip.

On the other hand, with the fine-pitch radial tooth cutter, several teeth may be at work at a time, each taking a light chip; consequently, the strain on each tooth is less, so the cutter speed can easily be increased. The hook-tooth cutter is of no particular advantage in so far as stellite is concerned.

Inserted-tooth Milling Cutters

There is much more to take into consideration in the design of an inserted-tooth stellite milling cutter than in the case of solid cutters. As with solid cutters, the more blades there are, the less trouble is encountered in obtaining a good finish. The blades should not be set in the cutter body at too great an angle with the arbor hole (see Fig. 2), because this necessitates grinding the tooth to a rather thin edge that will not stand high speeds and the hammer-blow action to which each tooth is subjected. It is not reasonable to expect the same durability from a cutter having teeth set at an angle of 20 or 30 degrees, as from one with the teeth at an angle of, say, 6 degrees, as indicated in the lower part of Fig. 2.

The main idea in setting the blades into the body at an angle is to obtain cutting clearance, but this angle should not be so great that the cutting edge will not be supported properly. When the blades are set at an excessive angle, breakage is likely to result, an increased number of grindings is necessary, and the cutter will not operate efficiently except at low speeds where chatter is not so likely to occur. The body should be of steel and hardened; otherwise it may become marred on the back face from hard usage or in transportation, and this will prevent the cutter from being located true on the machine spindle. The back surface and the one against which the clamping nut bears must be

parallel, so the cutter will be square with the spindle when clamped. These surfaces must also be square with the bore in the cutter body.

Arrangement and Angularity of Blades

The blades in a cutter intended for milling steel should not have more than 7 degrees top rake angle, while those intended for milling cast-iron and semi-steel should be arranged radially or with a very slight rake angle. Fig. 3 shows part of an inserted-tooth cutter used for cast iron or semi-steel, which has a large number of blades. When the blades are set comparatively close together, the slots for alternate blades are made less deep than the others. If the slots were all made the regular depth, they would weaken the body too much. The blades must be a snug fit in the cutter slots. If they are fitted loosely in the slots, they will shift under the cut, causing a rough finish and an early breakdown of the cutting edges.

The blades may be held in place by clamps at the periphery, as shown in Fig. 3, and these may be arranged to hold the blades singly or in pairs. The blades may also be held by driving a taper pin into a slot between each pair of blades, or by slabbed taper pins driven against the side of each blade. The latter construction, while very common, is not recommended for stellite, because the blades will shift under the cut unless they are perfectly fitted in the slots and the

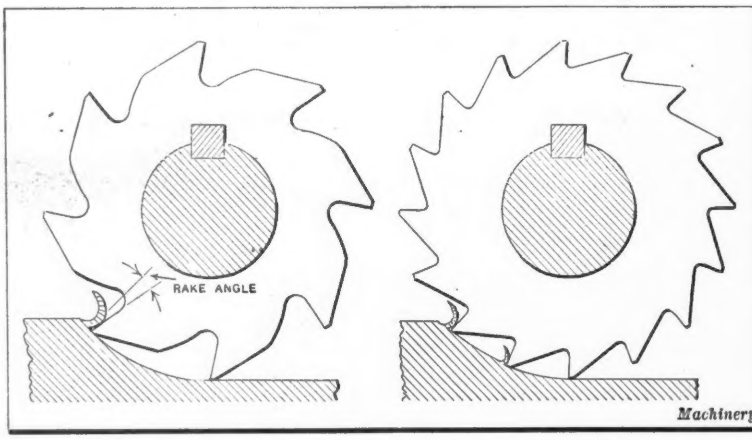


Fig. 1. Cutting Action of Milling Cutters of the Hook-tooth and Radial-tooth Types

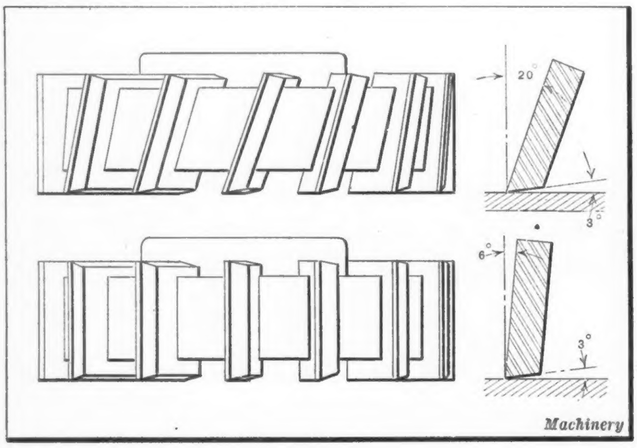


Fig. 2. Advantage of setting the Blades at a Comparatively Slight Angle in Inserted-tooth Milling Cutters

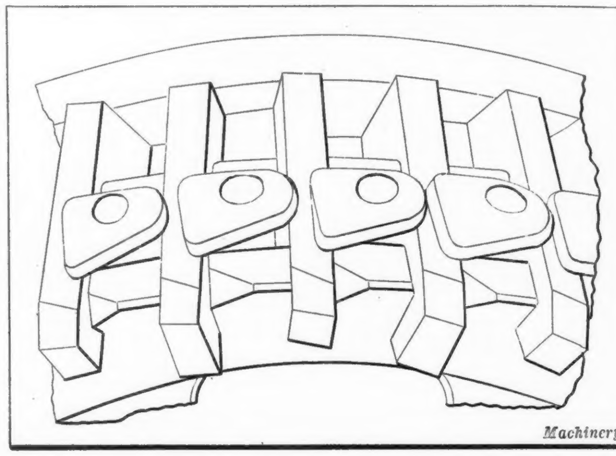


Fig. 3. Section of Inserted-tooth Stellite Milling Cutter for Cast Iron or Semi-steel

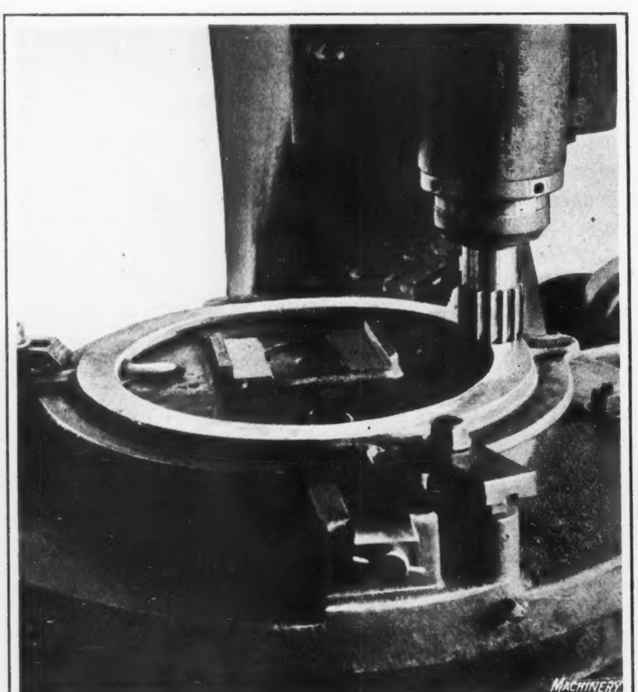


Fig. 4. Solid End-mill, 1¾ Inches in Diameter, 14 Teeth, milling Cast Iron; Cutter Speed, 210 Feet per Minute; Table Travel, 54 Inches per Minute; Depth of Cut, 3/32 Inch; Cutting Time, 42 Seconds; Pieces per Grind of Cutter, 380

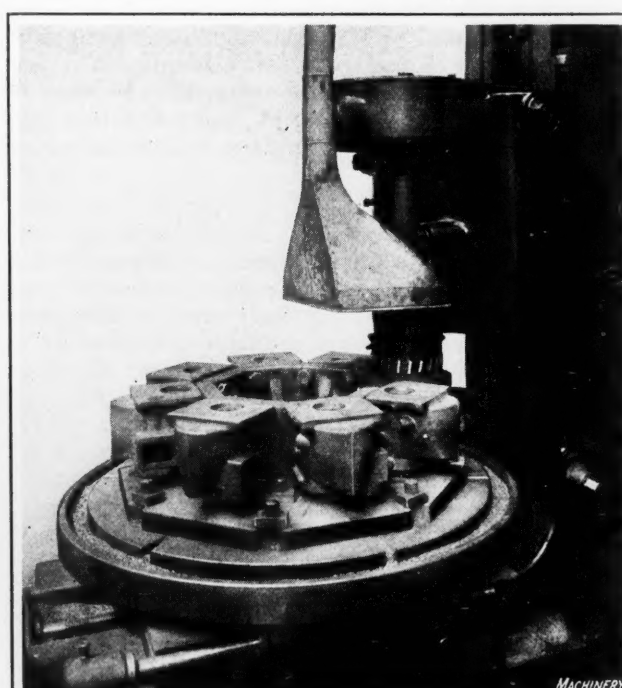


Fig. 5. Twelve-inch Diameter Cutter with 30 Blades milling Cast Iron; Cutter Speed, 147 Feet per Minute; Table Travel, 43 Inches per Minute; Depth of Cut, 3/16 Inch; Cutting Time, 30 Seconds; Castings per Grind of Cutter, 450

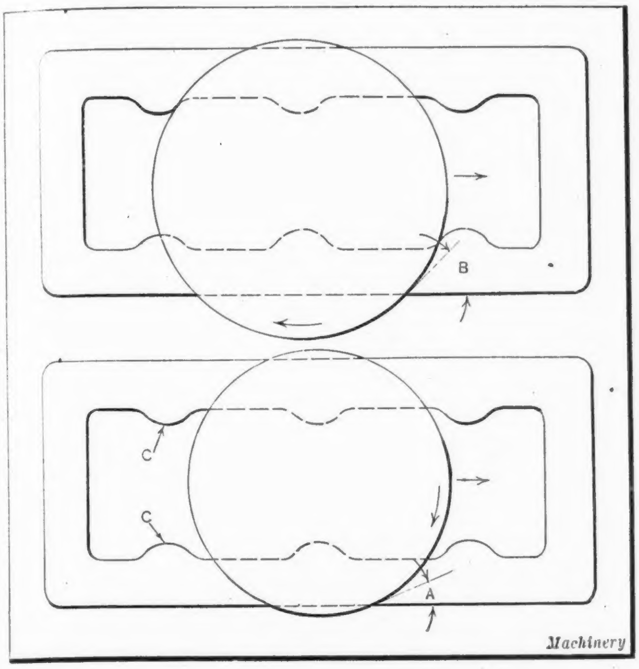


Fig. 6. Diagrams showing the Advantage of using a Face Milling Cutter somewhat Larger in Diameter than the Width of Surface to be milled

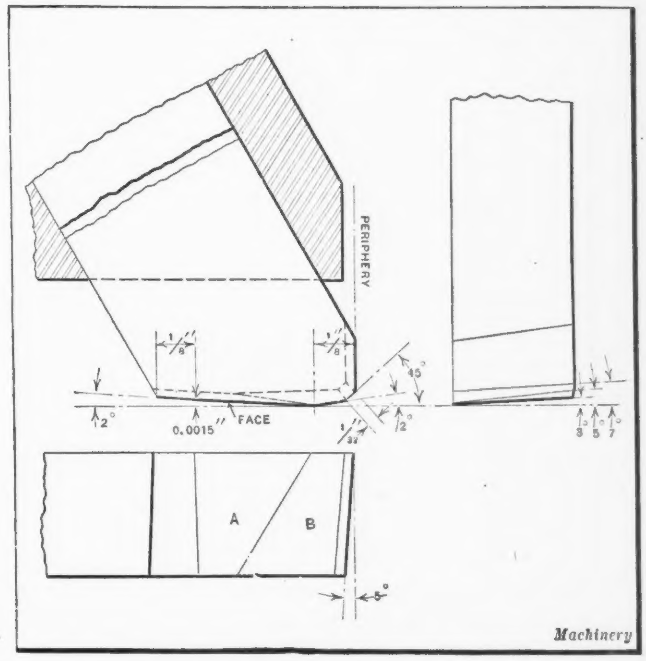


Fig. 7. Inserted-tooth Milling Cutter Blade as ground when the Cutter Axis is exactly at Right Angles to the Surface being milled

taper pins rest evenly against the blades. This is a condition that is difficult to maintain, especially in cutters with soft bodies, and the construction as a whole is expensive. With a fine-pitch cutter, where more blades are passing across the work per minute than in a coarse-pitch one, the hammer-blow action on each cutting edge is reduced, and there is no snapping out of one blade from the cut, upon the release of the cutting pressure, as is the case with a coarse-pitch cutter.

Large Cutters Recommended for Face-milling

For face-milling, the cutter should be larger in diameter than the width of the surface being machined. The diagrams in Fig. 6 illustrate this condition. When a casting is milled with a cutter that is just large enough to cover the width of the work, the angle of the blades as they emerge from the cut, designated by *A*, is too acute, and will cause the casting to chip off at the edge. If the casting is frail or is of the box type, there will also be a tendency for it to spring or to spread apart if the cutter strikes areas such as the two bosses *C* simultaneously. This may result in broken blades, fractured work, or low spots on the surface being milled.

It is apparent, in the case of the large cutter shown in the upper part of the diagram, that when operated off center it strikes these bosses one at a time, so that the effects mentioned will not occur. Furthermore, the angle of the cutter as it emerges from the cut, designated by *B*, is not as acute as angle *A*; hence the work will not chip off at the edge. A large cutter will also give longer service per grinding.

Grinding the Cutters

The first operation in sharpening all stellite cutters—of the solid or inserted-blade type—is to grind the face at an 8-degree clearance angle. The second operation on the solid type consists of grinding a land on the cutting edge, 1/16 inch wide, with a 3-degree clearance angle. The object of grinding the larger clearance angle first is to leave a fine edge to facilitate the grinding of the 3-degree angle. This enables the desired results to be obtained more quickly and with greater accuracy.

Blades for inserted-tooth cutters are ground with the 3-degree land, to the forms shown in Figs. 7, 8, and 9. The clearance on the periphery of the blades is 5 degrees for a table travel of 8 inches per minute; 6 degrees for a

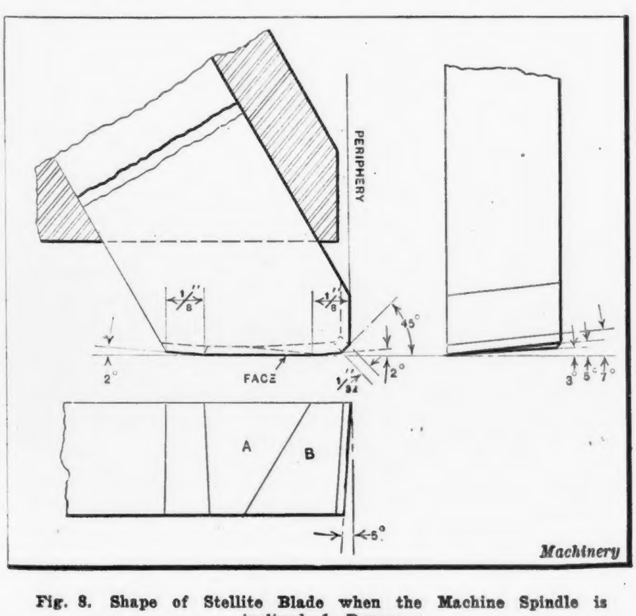


Fig. 8. Shape of Stellite Blade when the Machine Spindle is inclined 1 Degree

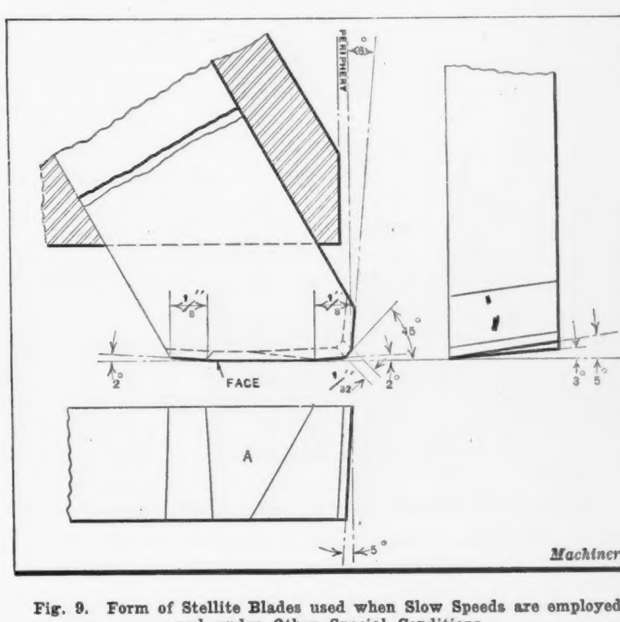
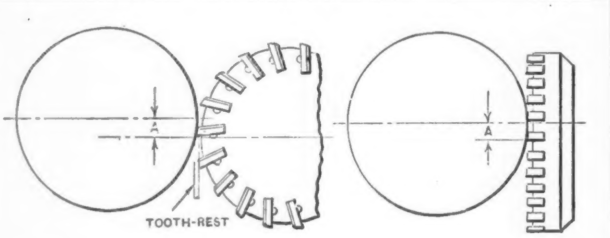


Fig. 9. Form of Stellite Blades used when Slow Speeds are employed and under Other Special Conditions

TABLE 1. DISTANCES FOR SETTING MILLING CUTTER BELOW GRINDING WHEEL FOR GRINDING FACE AND PERIPHERY CLEARANCES WITH DISK WHEEL



Diameter of Wheel	A for 3 Degrees Clearance	A for 4 Degrees Clearance	A for 5 Degrees Clearance	A for 6 Degrees Clearance	A for 7 Degrees Clearance
¾	0.020	0.026	0.033	0.039	0.046
⅞	0.023	0.031	0.038	0.046	0.053
1	0.026	0.035	0.044	0.052	0.061
1⅛	0.030	0.039	0.049	0.059	0.069
1¼	0.033	0.044	0.055	0.065	0.076
1½	0.039	0.052	0.065	0.079	0.092
1¾	0.046	0.061	0.076	0.092	0.107
2	0.052	0.070	0.087	0.105	0.122
2¼	0.059	0.079	0.098	0.118	0.137
2½	0.066	0.087	0.109	0.131	0.153
2¾	0.072	0.096	0.120	0.144	0.168
3	0.079	0.105	0.131	0.157	0.183
3¼	0.085	0.113	0.142	0.170	0.198
3½	0.092	0.122	0.153	0.183	0.214
3¾	0.098	0.131	0.164	0.196	0.229
4	0.105	0.140	0.174	0.209	0.244
4¼	0.111	0.148	0.185	0.222	0.259
4½	0.118	0.157	0.196	0.235	0.275
4¾	0.125	0.166	0.207	0.248	0.290
5	0.131	0.175	0.218	0.262	0.305
5¼	0.138	0.183	0.229	0.275	0.320
5½	0.144	0.192	0.240	0.288	0.336
5¾	0.151	0.201	0.251	0.301	0.351
6	0.157	0.209	0.262	0.314	0.366
6½	0.170	0.227	0.283	0.340	0.397
7	0.183	0.244	0.305	0.366	0.427
7½	0.197	0.262	0.327	0.392	0.458
8	0.210	0.279	0.349	0.418	0.488
8½	0.223	0.297	0.371	0.445	0.519
9	0.236	0.314	0.392	0.471	0.549
9½	0.249	0.332	0.414	0.497	0.580
10	0.262	0.349	0.436	0.523	0.610

Machinery

table travel of not more than 15 inches per minute; and 7 degrees for a table travel up to 20 inches per minute. An increase in the rate of table travel means an increase in the peripheral clearance to prevent the heel of the cutter blade from striking the work. The two accompanying tables give the distances for setting the grinding wheel relative to the cutter for grinding the various angles; the first refers to the use of a disk wheel, and the second to the use of a cup-wheel. They apply to both solid and inserted-blade cutters.

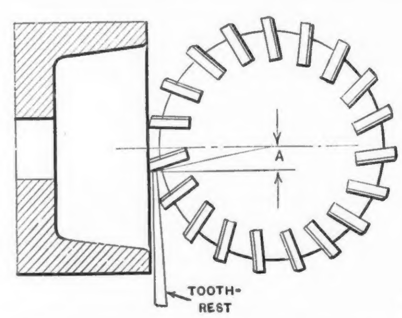
Table 1 gives the distances that the center of the cutter must be below the center of the grinding wheel when grinding the face clearance angles or the periphery clearance angles. These angles are from 3 to 7 degrees in magnitude, the largest grinding wheel size being 10 inches in diameter. Table 2 gives the distances for setting the tooth-rest below the center of the cutter when grinding peripheral clearance angles of from 3 to 7 degrees inclusive with a cup-wheel, for cutters up to and including 14 inches in diameter.

When the axis of the cutter is exactly at right angles to the surface being milled, the blades of an inserted-tooth face milling cutter are ground as shown in Fig. 7, with a 5-degree clearance on the periphery, a clearance on the face *B* of 5 degrees, and a clearance of 3 degrees on the face *A*. There is a 1/32-inch flat on the 45-degree bevel at the corner, with 7 degrees clearance. Both faces *A* and *B* are ground at an angle of 2 degrees to prevent tool marks.

On some planer type milling machines, the spindles are inclined at an angle of 1 degree to the vertical or the horizontal. In that case the cutters are ground as shown in Fig. 8. This form is used principally for finishing or for taking one cut only. The periphery clearance is 5 degrees. The blades are ground so that the edge of the blade at the face will be straight, with a clearance of 3 degrees. The face *B* has a 5-degree clearance, the same as in Fig. 7. Both the heel and toe are ground at an angle of 2 degrees.

When it is not possible to obtain the proper cutting conditions for stellite cutters, and slow speeds must be employed, the blades are ground as in Fig. 9. This method of grinding is also used frequently on intermittent milling operations, and where the blades of two cutters interlock or take alternate cuts. When milling a surface at 90 degrees with a face that has already been finished, especially if taking a heavy cut, the work will probably chip off where the two finished edges come together, unless this tooth form is adopted. It should also be used when milling a light casting or one having thin walls, ribs, or flanges. In case several cutters are working on one side of a casting and only one on the opposite side, it is best to have the cutting edge of the surface *A* parallel with the work on the single cutter side.

TABLE 2. DISTANCES FOR SETTING TOOTH-REST BELOW MILLING CUTTER CENTER FOR GRINDING PERIPHERY CLEARANCES WITH CUP-WHEEL



Diameter of Cutter	A for 3 Degrees Clearance	A for 4 Degrees Clearance	A for 5 Degrees Clearance	A for 6 Degrees Clearance	A for 7 Degrees Clearance
¾	0.020	0.026	0.033	0.039	0.046
⅞	0.023	0.031	0.038	0.046	0.053
1	0.026	0.035	0.044	0.052	0.061
1⅛	0.030	0.039	0.049	0.059	0.069
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1½	0.039	0.052	0.065	0.079	0.092
1¾	0.046	0.061	0.076	0.092	0.107
2	0.052	0.070	0.087	0.105	0.122
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9	0.236	0.314	0.392	0.471	0.549
9½	0.249	0.332	0.414	0.497	0.580
10	0.262	0.349	0.436	0.523	0.610
10½	0.275	0.367	0.458	0.549	0.641
11	0.288	0.384	0.480	0.575	0.671
11½	0.301	0.401	0.501	0.602	0.702
12	0.314	0.419	0.523	0.628	0.732
12½	0.328	0.436	0.545	0.654	0.763
13	0.341	0.454	0.567	0.680	0.793
13½	0.354	0.471	0.589	0.706	0.824
14	0.367	0.489	0.610	0.732	0.854

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Instead of this special shape, blades ground with a large 45-degree angle are often used with slower speeds. The shape in Fig. 9, however, is more efficient, because the toe of the blade, when ground as shown, can get under the hard scale, while the edge of a broad corner becomes dull rapidly.

The various methods of grinding shown apply to the milling of cast iron and semi-steel; for steel, the face is ground to a sharper angle. In milling aluminum with an inserted-tooth milling cutter, the blades are set at an angle in the body to give them a negative rake of about 6 degrees, although some manufacturers use the types of cutter blades recommended for cast iron. Negative rake allows the blades to strike the hard spots in cast aluminum called "nigger heads," which extend above the cutting edge and have a tendency to dull the tool.

Inspection of Cutters

It is almost needless to state that the cutters should never be returned to the milling machine after grinding without being inspected. For this purpose, special inspection methods are in common use, in which an indicator is employed to test the relative positions of the cutting edges. If some blades are allowed to project even slightly beyond the others, tool marks result. When a few high teeth do all the cutting, the cutter will work with equal efficiency and as economically if some of the blades are removed, because the metal is being continually ground away from several teeth that do no actual cutting. These high teeth also dull very quickly and leave a rough finish, because of the land worn on their cutting edge.

Often an operator will stop his machine to inspect the cutter, because he sees that the surface of the work is not smooth. The dull teeth will have a certain amount of brake power, and may be under the cut when the machine comes to a stop, and the teeth that are seen will appear sharp. When cutting is resumed, the dull teeth are often broken out, with resultant damage to the cutter body and the surface of the work.

* * *

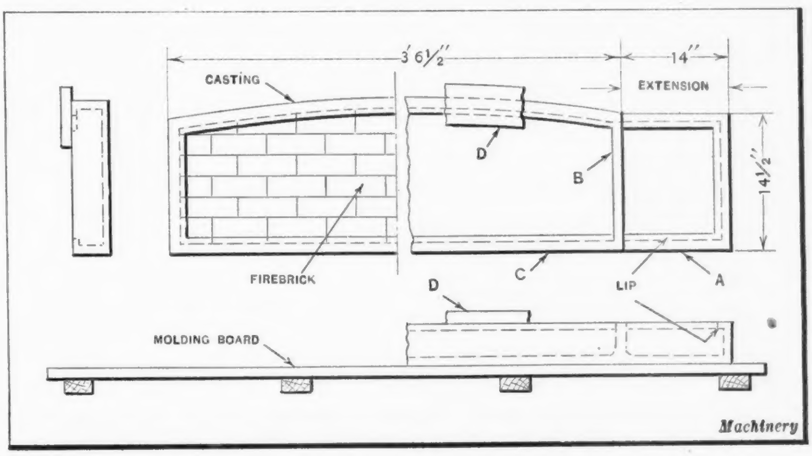
INCREASING THE SIZE OF A STANDARD PATTERN

By M. E. DUGGAN

The patternmaker is often called upon to make temporary changes in a pattern so that it can be used in the production of a special casting. In the present article, the use of extensions as a means of increasing the size of a pattern for a muffle furnace door is described. The extensions, one of which is shown at *A*, are 14 inches long. As only two of the special castings were needed, the patternmaker was instructed not to change the standard pattern. However, he decided that the ends *B* of the standard pattern must first be removed, and that the extension pieces at each end should be fastened to the body pattern *C* with stop-off strips temporarily fastened with screws to the sides of the pattern. The retaining lip pattern was made in the form of a frame, separate from the body pattern, and loosely held in place by wire nails, which served as dowel-pins.

The pattern was to be made in a two-part flask. In order to preserve the standard lip frame for future use, a new frame was made to correspond with the dimensions of the altered pattern. In making the new frame—which was intended to be used in the production of two castings only—the patternmaker did considerable work that was uncalled for and unnecessary. First, he made the lip frame, and on this frame built a core-print ¾ inch in thickness and 2 inches wider than the lip. The core-print, therefore, overlapped the lip on each side a distance of one inch. He also made two core-boxes, one for the curved top, and one for the straight section. These core-boxes were made approximately 24 inches long, so that two cores were required to reach the entire length of the pattern.

The removal of the end pieces from the standard pattern was unnecessary. As only two of the special castings were required, the two cavities left in the mold by the end pieces, after withdrawing the pattern, could be easily filled up and smoothed over by the molder. For the extension pieces, all that was required was two boxes, each consisting of a bottom and two sides, as shown in the illustration. The one-piece lip frame—although considered good patternmaking practice—was not required. This frame could have been made of short sections or pieces temporarily held in place with short wire nails. The wire nails, acting as dowel-pins, should be a tight fit in the frame and a loose fit in the body pattern.



Half-section of Muffle Furnace Door lined with Firebrick; and Half-section of Pattern as arranged to produce a Longer Door Casting

The way in which the mold was actually made was as follows: The pattern was placed with its bottom down on a molding board, as shown in the lower view. On the molding board were placed the extension pieces *A* with their open ends against the ends *B* of the pattern. The lip frame or lip sections were next placed in position on the pattern. The wire nails in the frame, acting as dowel-pins, served to hold the loose ends in place against the ends *B*. The drag flask was next placed around the pattern on the bottom board. Sand was then shoveled in up to the top of the loose-lip frame, and the surplus sand struck off, after which the frame was lifted and the mold finished in the usual way. Cover or "ram-up" cores, as they are commonly called, were then placed over the space left by the lip frame. A section of one of these cores is shown at *D*. The cover cores could have been made from pieces of cores of various lengths. The pieces used for this purpose should, of course, be wide enough to provide a good bearing surface on the molding sand. When the cover cores were set in place, the filling in of the sand was continued to the top of the drag flask, which was finished in the usual way. The drag flask with the pattern in place was then rolled over ready for the cope flask. The cope flask was placed on the drag, after which it was filled in with sand and rammed up.

The cope was next lifted and the pattern withdrawn, the extensions being drawn first. After mending the mold, the cope was placed back on the drag and locked in place; the mold was then ready for pouring.

* * *

The cost of transporting materials by different means is compared in the Journal of the Society of Automotive Engineers. It is stated that $1 will haul a ton of freight 9 miles by horse and wagon; 24 miles, over good roads, by motor truck; 185 miles by railroad; 230 miles by canal; and 3000 miles by ship on the high seas.

Work-holding Surfaces of Machine Tools

Table Design for Different Types of Machines—First of Three Articles

By FRED HORNER

MACHINE tools are generally designed and built around the work-holding surface, the next consideration being the matter of holding and operating the tool. Without an efficient work-holding medium, a machine cannot be made to operate successfully. The early method of always fastening the work directly to a certain surface gave way to the use of special holding devices, jigs, and fixtures in connection with this surface. Of recent years, single-purpose machines have been built with special holding appliances that have nothing in common with ordinary tables or plates. These appliances are usually not adaptable for more than one part, nor is it intended that they should be. Sometimes an ordinary table surface is provided, on which is mounted a supplementary table having suitable supporting faces to receive the special shapes of pieces to be machined. Most machines, however, are built with ordinary holding surfaces adapted to securing any usual shape of casting or forging, together with special jigs, fixtures, centers, angle-plates, and other accessories.

Holding Conditions Vary with the Type of Machine

Certain variations regularly occur in holding surfaces, these variations being demanded by the shape of parts, direction of thrusts, or considerations of convenience in making adjustments. The conditions with a small table of a foot or so in width are not the same as those with a large baseplate. Neither are the cutting conditions similar, for instance, on a drilling machine and a planer. The thrusts and shocks are vastly different in the two. Furthermore, some classes of machines require greatly increased facilities for applying bolts and clamps, either because the work is varied and awkward to secure, or because the parts must be set up on the machine in quantities. There must also be possible the rapid transposition of bolts and stops about the clamping area to suit the best positions. Finally, reserve positions should be left for extra clamps, stops, struts or angle-plates, for effectually blocking the work against movements unexpectedly found to take place when machining the part.

Another factor in design that particularly affects some machine tools relates to abnormal capacity. Given a definite extent of holding surface of, perhaps, 3 by 5 feet, the problem may arise of how to make this surface accommodate abnormal sizes. Lately, this point has received much attention; for example, most milling machine tables now have a greater holding surface than was formerly the rule with a machine of the same size, the alteration having been brought about by raising the rim of the oil-pan surrounding the table to the table level, and machining it off uniformly. Thus, although the draining provision is still there, the table is in effect longer and wider, and equal, for many purposes, to the table on the next size of machine. The extension of the T-slots into the suitably thickened rim adds still further to the usefulness of the new construction.

Supplementary Supports

Another manner in which increased area may be obtained is by the bolting on of a supplementary plate, such a device being sometimes employed on shapers and boring and drilling machines. A cheaper and quicker scheme consists in placing a strip or bar, or a pair of these, so as to overhang the table and sustain a long object. Still another method that is handy with slides on long beds is to add a narrow table at a suitable place on the bed so that the piece overhanging the main table may rest on the supplementary one. This problem partly depends on whether the work moves or not, and is usually more difficult in the former event. Stationary work may be readily blocked up on the shop floor, or on a baseplate, whereas moving work must rest on a true surface, or be arranged upon a slide or a roller device which will maintain it in true alignment with the tools for the extent of the travel or adjustment.

Instead of altering the position of a cross-rail, drill head, or arm for a small number of pieces, it may be simpler to provide a supplementary support or table to raise the work. If the weight of the work is not too great, or its bulk prohibitive, a vertically adjustable table supplies a solution to the difficulty, and possesses the advantage of easy change of horizontal location, by swinging, sliding, or rotary movements. But should the work be too bulky or awkward to secure, the preference lies with a low base, on which the work remains stationary and the tool is adjusted to suit.

Thrust Factor in Table Design

The matter of thrust has an important bearing on table design. Sometimes the tool pressure is in a direct line

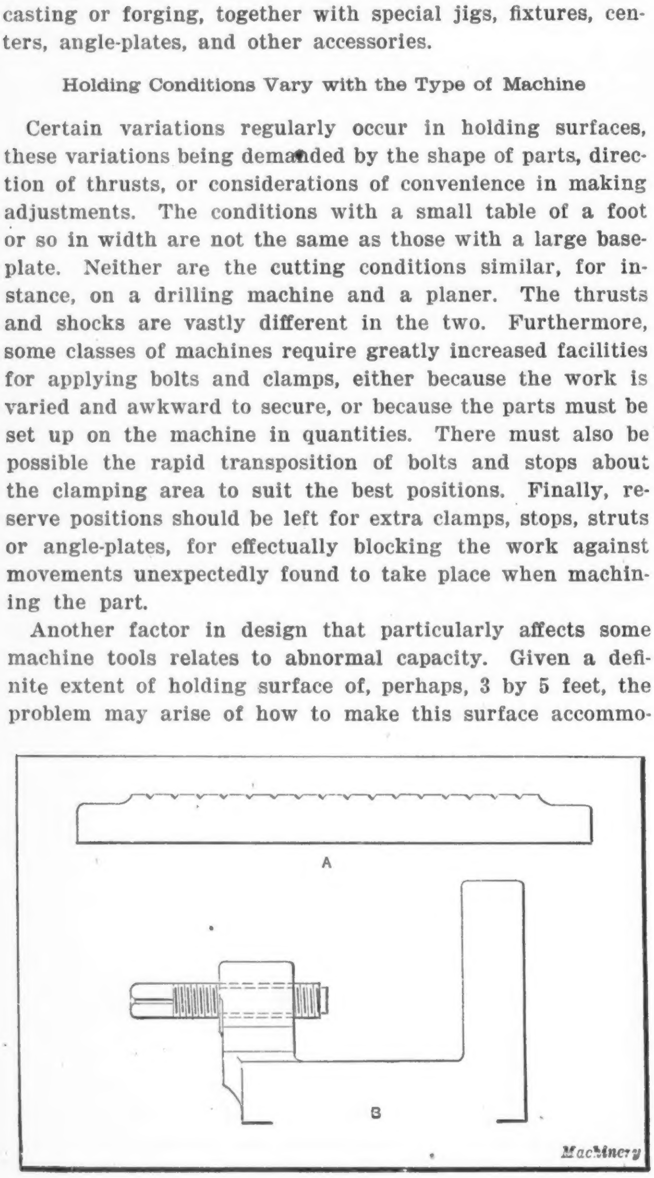


Fig. 1. (A) Grooves provided on Grinder Table to remove Dirt from Supporting Surface; (B) Arrangement employed for clamping Rails on Drilling Machine Table

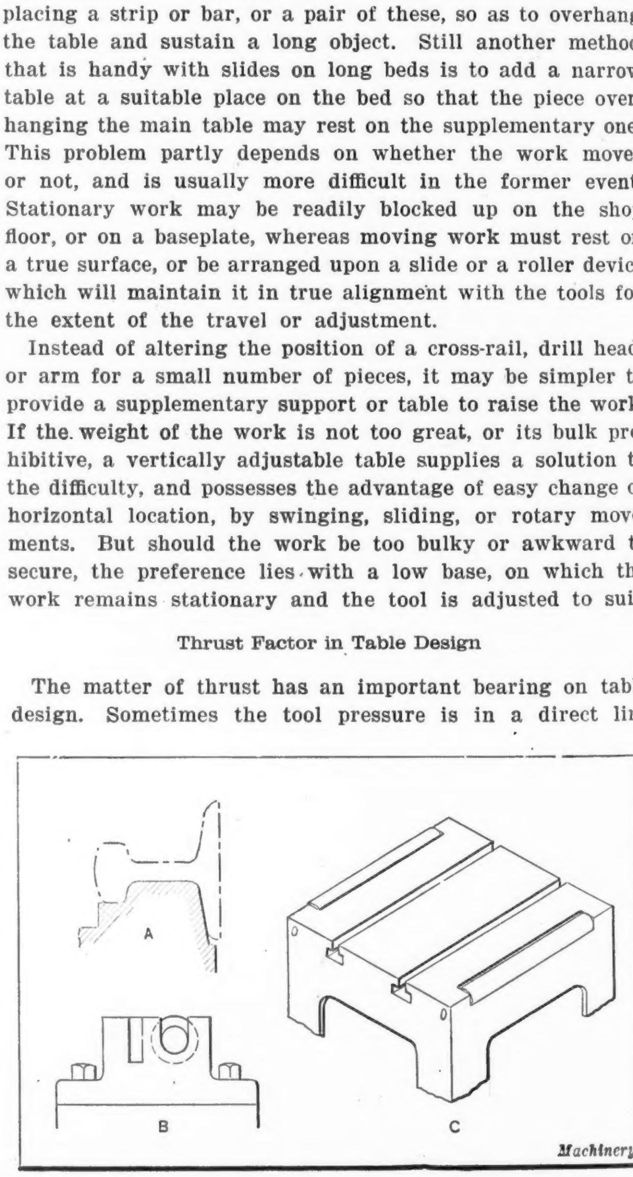


Fig. 2. (A) Holding Surface having a Contour Similar to the Profile of the Part it supports; (B) Roller Support for Drilling Machine; (C) Roll Table

against the holding face, at right angles to it, or in an oblique direction. Some machines have thrust always in one direction, others in two opposite directions, while still others may have thrust from all points of a circle. Special provisions are necessary to take thrust on planers and milling machines not only in a direct line with the cutting pressures, but radially also, because the tendency of the tool when at a corner is to swing the work around on the table. Side stops prevent this. On a boring mill table there are severe side and twisting pressures, and when the chuck jaws do not surround the work effectually, it is necessary to use screw stop-pins or stop-plates. In such examples as the foregoing, there must consequently be ample facilities in the table construction for the reception of stop-plate bolts, plain round stops, or angle-plates, without interfering with the use of plenty of holding-down bolts.

If castings are high, their overturning tendency must also be taken into account. This necessitates an ample space around the base of such castings for placing adequate blocking, angles, or struts. With repetition production, the difficulty is reduced, because jigs or fixtures can be employed to locate and secure awkward shapes on a smaller size of table than would otherwise be necessary. In special instances, stops alone are used, as with magnetic chucks where the side thrust is not resisted effectively by the magnetic pull. Here T-slots are only occasionally employed for holding-down bolts.

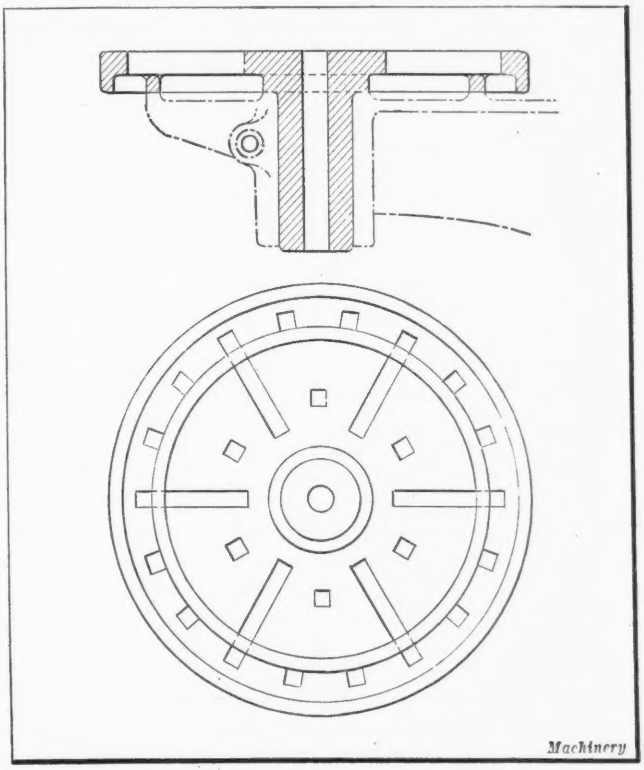


Fig. 3. Drilling Machine Table with Through Holes and Slots

Either horizontal, vertical, or inclined holding surfaces are met with in most types of machine tools. The fact that the holding surface lies in one or another of these planes may or may not make an essential difference in holding the work, lubrication, and other details. Modifications of T-slots are sometimes met with in vertical surfaces to prevent slippage of bolts, while modified designs of coolant pans or rims become essential when the plane is changed from the horizontal. Difficulties encountered with very heavy jobs may necessitate the addition of narrow adjustable tables or angle-brackets, to sustain the weight during the adjusting and bolting, but frequently the same service is supplied by wood blockings resting on the floor or at the bottom of a pit when the latter is provided for deep work.

Plain Work-holding Surfaces

A detailed examination of the principal features of holding surfaces provided on machine tools will now be made. The first class of surface to be considered will be the simplest—that where the job is laid on and held by the hand alone. The part is laid on a smooth rest or table, and the cut taken by pushing up to the wheel on a grinding machine or feeding the drill on a drilling machine. A factor that militates against accuracy in grinding is the presence of dust between the table and the under side of the part. This difficulty is lessened only by frequent wiping off. If the operation is comparatively accurate, the trouble can also be reduced by providing V-grooves on the resting surface, as shown at *A*, Fig. 1, or deeper U-shaped grooves to catch the dirt as the piece is slid along. The ridges also assist in securing a better frictional grip. Guide strips and protractors are applied to disk-grinder tables, to locate and support objects in definite positions relative to the disk wheels. The holding down still depends on the hand, but accuracy as to angles comes from the presence of the strips, which also take the lateral thrust.

On disk and other grinders, a strong clamp is often used to hold down the parts being ground, a quick-acting cam device being favored for the sake of rapid changing. On some drilling machines specially designed for such parts as long strips or rails, a plain table provided with a back-plate receives the rails, and these are gripped by means of a lateral screw as shown at *B*. A similar idea is followed in saw machines for cutting long strips, girders, and rails, either singly or in multiple, plain holding surfaces being utilized in conjunction with clamping screws, with or without special shaped pads on their ends. When a close and firm support happens to be desirable, a departure can be made from the plain flat surface and a profile surface provided, such as illustrated for a rail at *A*, Fig. 2. Supports like this may be interlocked, one above another, and the whole clamped down with a screw and pad.

Another case where there is no need for a slotted table, with bolts and clamps for securing the work, is in the drilling of long girders, plates, and other parts for constructional work on a multiple-spindle machine. Frequently sufficient support is provided by a series of narrow brackets, which hold the girders on their top edges. Bolt slots may or may not exist on these narrow tops, but if they do, their chief function is to fasten stop-plates for controlling the cross position of the long pieces as they are slid along under the drill spindles. The need of rapidly sliding heavy jobs with the minimum of effort sometimes renders the addition of rollers desirable, as illustrated at *B*. A wider table with slots for general work may likewise possess rollers at the ends, as shown at *C*.

Securing Bolts to Surfaces by Tapped Holes

The means for securing bolts to work-holding surfaces include tapped holes, plain through holes or slots, dovetail slots, and T-slots. The relative merits of each vary according to circumstances, such as the frequency with which the bolts must be changed or loosened, the respective changes in their position, the strain imposed, the positions of the surfaces clamped, and the facility with which the bolts can be put in place and removed. Generally speaking, tapped holes are only suitable in cases where the bolts do not require frequent changing. Tapped holes may lose their size, and the threads may lose their effectiveness of hold, with repeated use. This difficulty never occurs with plain holes or slots under the most severe duty. Heavy side pressures are also detrimental to the durability of the threads, causing them to lose their shape, especially in cast-iron tables.

A further objection to tapped holes is their liability to choke up with dirt, fine chips, and lubricant. While this may be obviated by the insertion of plugs during periods of non-use, the time occupied by the insertion and removal

and the risk of neglecting to do so are a distinct drawback. The principal advantage of tapped holes lies in the fixedness of their position, so that the screws when manipulated cannot slide to the right or left, as in a slot. This feature is especially advantageous when clamps are required to remain in the same position for successive pieces.

A good many shaper and grinding machine tables are supplied with threaded holes, the latter being also furnished on the work-holding surfaces of continuous milling machines of both the vertical and the horizontal types. Upstanding ledges or tongues are largely used in these cases to receive the thrust of the cut, and thus relieve the cap-screws to a considerable degree. The work-holding surfaces on many special-purpose machines, however, serve also for the reception of fixtures that remain in position for long periods, and so the threads are practically immune from wear or rust. Some machines, both of ordinary and special design, have tapped holes on the work-carrying areas simply for the purpose of fastening down centers, rotary arbors, or other equipment, which always occupies the same position. Threaded holes are also occasionally located on the sides and ends of tables or bases for special functions in connection with the holding of work. If they do not interfere at other times, stud bolts may be screwed into the holes to offer a slightly quicker means of setting up the job.

Use of Through Holes and Slots

At an early period of machine tool construction T-slots were unknown and all tables and plates had simple through holes instead, in which the bolts generally had to be inserted from the back. Even the advantages of slots, by contrast with round or square holes, were not taken much note of, and bolts had to be withdrawn from one hole and put through the next for a small change of position. This practice, which now appears annoying and time-wasting, was partly unavoidable, because the tables were thin and poorly supplied with ribs. A box section construction was unknown. The principal designs in which through apertures are still retained are those where it is not difficult to quickly pass bolts through from the rear, or where there is no danger to the operator in so doing. It will be apparent that these do not include numerous kinds of box tables, long tables sliding on beds, baseplates close to the floor, and plates or tables carried on pivots or stems which bring them so close to other parts as to prevent the use of bolts.

The necessity of draining coolant from all over the holding area of a table may modify the slot arrangements. A table not provided with draining facilities can have through slots, whereas a similarly arranged table with proper draining devices will require T-slots in order to leave no openings. A great objection to through slots is that the bolts fall down as the clamps are slid off the work, or tumble through as the nuts are removed. This fact involves great inconvenience and waste of time. The expedient of using a nut to lock the bolt from above is sometimes resorted to. Types of machines now having through holes and slots, or a mixture of the two, include light drilling machines, small shapers, a few special machines embodying angle-plate holding surfaces, and certain multiple-spindle drilling machines having long tables suspended between supports so as to leave a considerable free space underneath the table.

On a simple drilling machine table the slots should be disposed so as to afford universal facilities for locating and sliding the bolts. The table shown at *A*, Fig. 4, meets these requirements fairly well, the four radial slots enabling in and out adjustments, and the interspaced ones movements which come in handy for working around the circle, not only outside the work, but within openings, etc. Stop-pegs to resist swinging of the work can furthermore be added at any distance from the center.

On a larger table the number of slots naturally increases, and four T-slots may be included in the set. A combination of through holes and slots is shown in Fig. 3. On small shaper tables the thin flanks may be perforated by slots, as shown at *B*, Fig. 4, or the slots may be arranged horizontally so that the bolts cannot slip down. Sometimes it is possible to cast gaps at suitable places to permit bolts to be dropped in from above instead of from the rear. This arrangement is occasionally adopted for massive planer tables of box section, and for rotary planer work bases. Two different lay-outs of such slots may be observed at *C* and *D*, the gaps being spread well apart so as not to weaken the plate materially.

T-slots on Machine Tool Tables

The old dovetail slot has practically disappeared from designs of work-holding surfaces in American and British practice, though many examples still are found on machines built on the continent of Europe. The obvious objection to this type of slot is the weakness of the bolt head and the metal near the top of the slot. This will be apparent by reference to *A*, Fig. 5. When lateral pressure on the bolt is severe or violent shocks arise, the wedging and wrenching-out tendency of the head is greatly intensified.

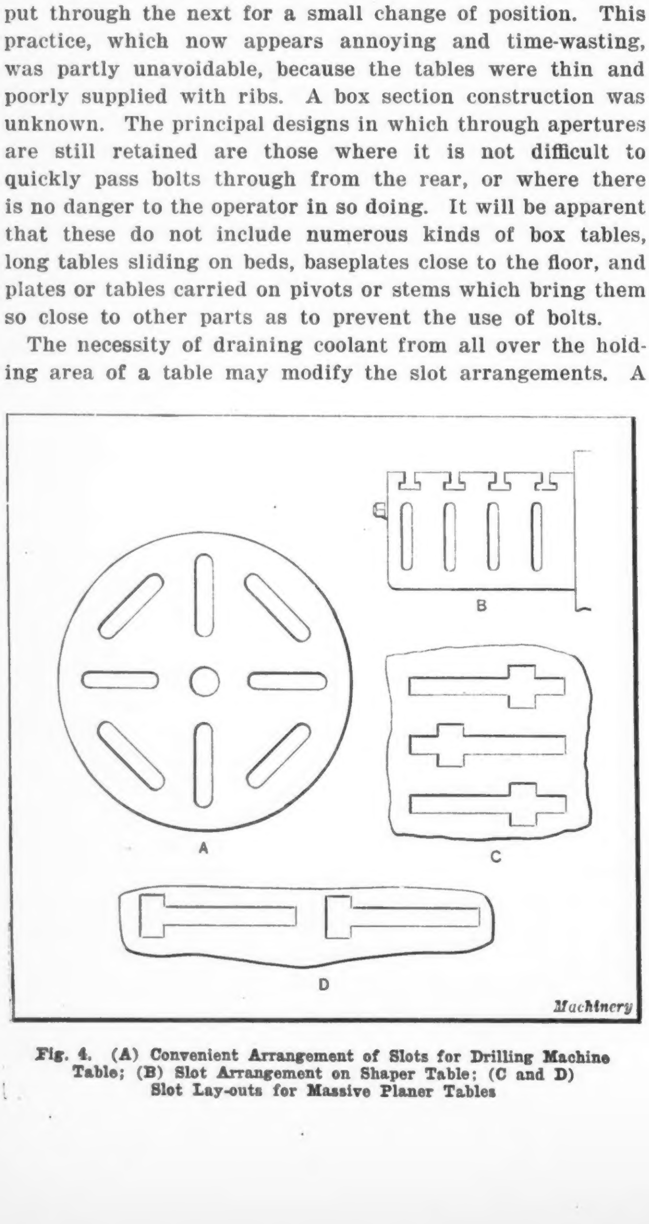


Fig. 4. (A) Convenient Arrangement of Slots for Drilling Machine Table; (B) Slot Arrangement on Shaper Table; (C and D) Slot Lay-outs for Massive Planer Tables

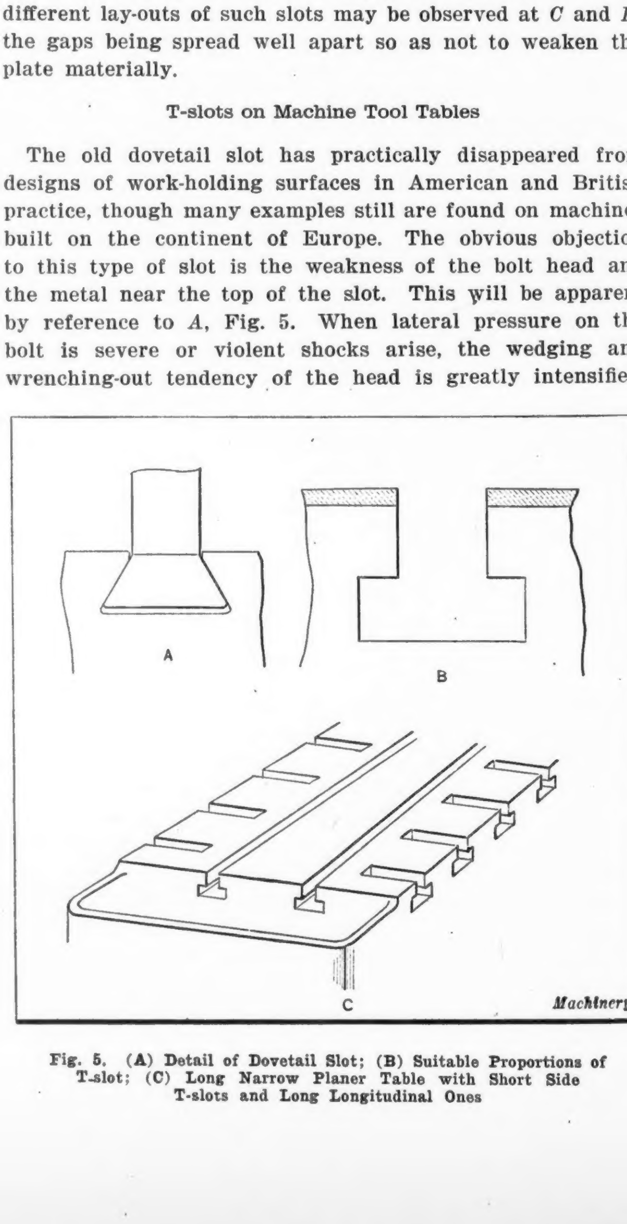


Fig. 5. (A) Detail of Dovetail Slot; (B) Suitable Proportions of T-slot; (C) Long Narrow Planer Table with Short Side T-slots and Long Longitudinal Ones

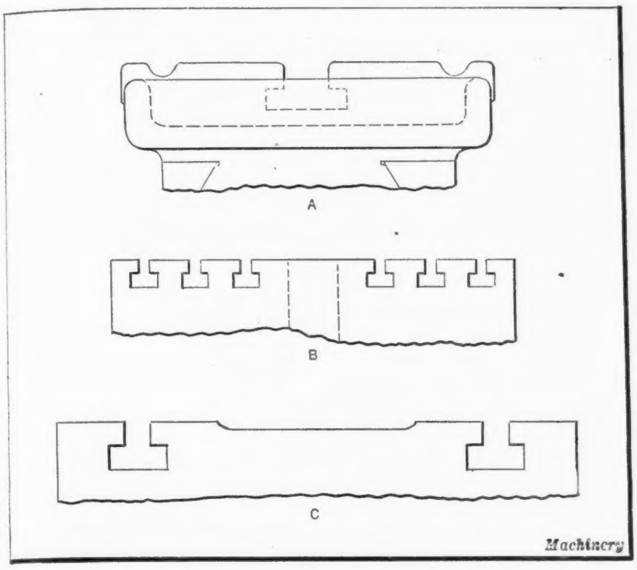


Fig. 6. Various Methods of arranging T-slots on Machine Tables

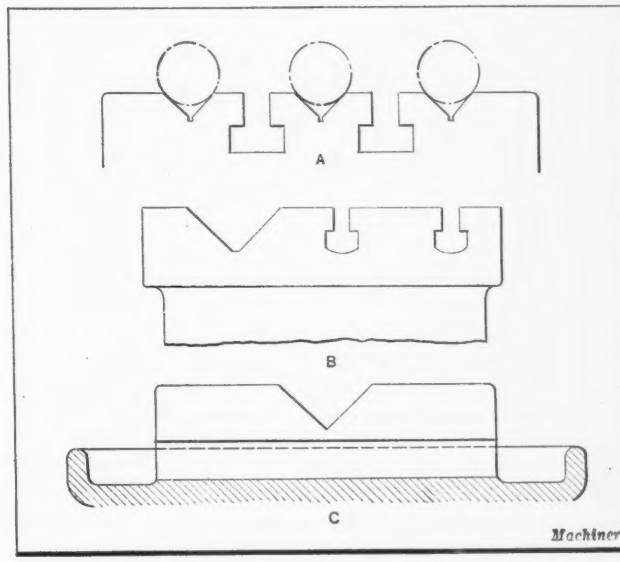


Fig. 7. Tables provided with V-grooves in addition to T-slots

The square-cornered T-slot holds the field now, and appears on practically all the principal types of machine tools. Some care in thinking out the proportions of the slot and bolt is essential. There must not only be ample metal to resist the distortion or bursting effort of the bolts, but the weakening effect of numerous slots on a table must also be borne in mind. The provision of ample metal around the slots, or deep ribbing, or the employment of a box section, all tend to increase the strength.

Another point not always given sufficient attention in designing a table relates to subsequent changes in the table thickness. Refacing or skimming up of the table surface frequently occurs in the course of its use, and unless the metal above the lip of the slots is ample, a dangerous weakening takes place in this subsequent truing. This is especially the case with magnetic chucks, which are generally reground several times during their life. The top of the T-slots should consequently be surrounded by plenty of metal, so that the gradual removal of the table surface will still leave the depth of metal ample. At *B*, the proportion of surface which may be safely removed is indicated by dot-and-dash section lines.

The practice of making denser castings, casting the T-slots with chills and mixing a proportion of steel with the iron are procedures that make for stiffness of tables and durability of slots. Another strengthening factor is the casting of tables integral with stiff trays, examples of which will be shown. The loads that tables must carry at present are much heavier than formerly, partly because heavy fixtures receive the parts to be machined, and partly because the cutting stresses are greatly enhanced, especially with multiple tooling methods.

Arrangement of T-slots

There ought never to be a large space without means for inserting or removing bolts without disturbing others; hence pockets should be cast for this purpose, or cross-connections be arranged to slide bolts in from the edges at numerous locations. Bolts with opposite corners of the head rounded off can be dropped into place readily, but are likely to loosen as the nut is slackened. Some surfaces are satisfactorily supplied with the slot or slots about the center, while others must have places for bolts close to the edges, as shown at *C*.

The direction of the slots varies in different machines and also in machines of the same kind but for special operations. A specific instance is the case of heavy plano-milling machines. Those for ordinary slabbing and facing cuts employ longitudinal slots like those on planer tables, but many of the heavy profiling machines have slots running across the table to provide easy lateral adjustments of the work and of the former device by which the profiling roller controls the cutter-slide. The relative dimensions of a table affect the direction and number of the slots, for a big area obviously gives room for the laying out of groups of slots in parallel groups, or possibly interspersed with radial or other slots.

The simplest design of table provided with a T-slot is represented at *A*, Fig. 6. This table is intended for a small hand miller, the slot being utilized to a considerable extent for fixture or vise holding, as well as for clamping work direct. The limitation of holding facilities on such a design is often reduced by providing a few tapped holes. Another design embodying slots well away from the center is shown at *B*. This is chiefly applicable to machines that have a central ram or bar passing down through the table; the one shown was built for a keyseater. Occasional instances of double-spindle machines that operate at the ends of long work, give rise to slots only at the ends of the table, as shown at *C*. The holding surface may run flush the entire length, or be recessed, as shown, and provided with a fixture resting on the machined surfaces to carry the work. The table represented is that of a duplex milling machine of modified Lincoln design.

Often the inclusion of grooves in a work-holding area influences the lay-out of the slots, which must be arranged with reference to the grooves. In a special planer for key-seating, the shafts rest in three V-grooves on the table, illustrated at *A*, Fig. 7, and two T-slots afford means of bolting. A different style of table is shown at *B;* this is used on a cold-saw cutting-off machine, where a single large bar, or several, are clamped down with a plate or bracket and screw. A series of transverse T-slots is cut in the keyway milling machine table illustrated at *C*. Ordinary clamping plates are used here from bolt to bolt.

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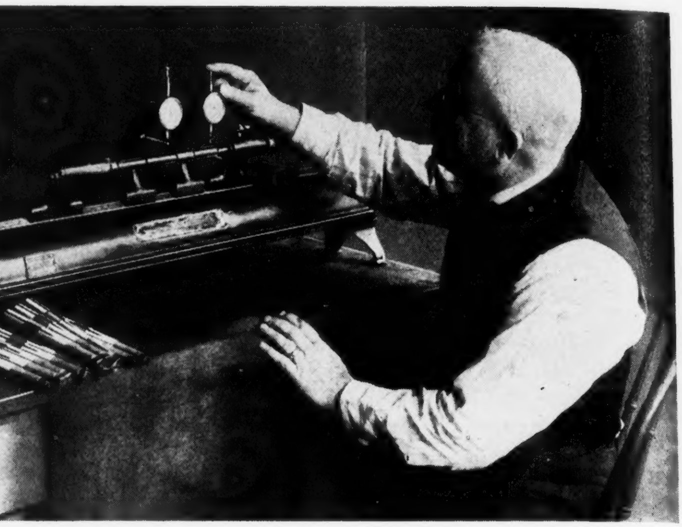
GRAPHITE CRUCIBLE INVESTIGATION

The final stage of the graphite crucible investigation, in which the Bureau of Mines, Washington, D. C., has been engaged for some years, has been completed. The object of this investigation was to determine the availability of domestic bond clays and domestic graphites for crucible making. During the war the obtaining of graphite and bond clays, which had been practically all imported, for making crucibles became a most serious problem. The bureau's investigations have shown that some American graphites and bond clays are, when properly prepared, equal or superior to foreign materials, for crucibles both in brass-making and in steel melting.

Manufacture of Adjustable Reamers



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Operations Performed on the Body, Nuts, and Blades of Adjustable Reamers

THE adjustable reamer called the "Quick-set," manufactured by the Cleveland Twist Drill Co., is of a type that has been known for many years. The production methods for this tool, however, have been worked out within the last two years, and represent modern methods applied to small tool manufacture. The reamer consists of a body with six longitudinal slots, in each of which is a blade. The blades are clamped in position by two nuts threaded on the body. The bottom of the slots are tapered longitudinally, as are also the bottom edges of the blades, so that, as the blades are moved in the slots, their outer surfaces expand cylindrically. The general construction of the tool is shown in Fig. 1.

As the market for this tool is large, its manufacture on a quantity basis is possible, and all the fixtures and methods used have been laid out with a view to large volume production only. A greater variety of operations are employed in making this reamer than is common in small tool work, and while most of them are not unusual in themselves, the degree of precision obtained is greater than ordinary. This article will explain in detail the processes employed.

The tool is made in eleven standard sizes designated by letters from A to K inclusive. Size "A" reamer has nominal expansion limits from 15/32 to 17/32 inch. Size "K" has corresponding limits from 1 11/32 to 1½ inches. The intermediate sizes are similar, and all sizes have actual working limits of a few thousandths inch above and below their nominal limits, so that one tool may enter a hole that has been reamed by the next smaller size.

The general production problem for these reamers is to obtain the accuracy required in such a tool, combined with interchangeability of parts, at production costs low enough to enable the tools to be sold in a highly competitive market. With minor modifications, the manufacturing processes are the same for all sizes. In order to make the subject matter clear, one size ("H") will be referred to in this article. The nominal expansion limit for this size is 15/16 to 1 1/16 inches. The reamer consists of three parts: (1) The body; (2) the nuts; and (3) the blades.

Operations on the Body

The body is made of low-carbon steel to the finished dimensions shown in Fig. 1. The operations are as follows:

1. Rough-turn one end and cut-off.
2. Inspect.
3. Center both ends.
4. Rough-turn other end.
5. Finish-turn one end.
6. Finish-turn the other end.
7. Inspect.
8. Mill square.
9. Recess.
10. Wash.
11. Burr square.
12. Inspect.
13. Harden square.
14. Grind.
15. Stamp.
16. Inspect.
17. Thread.
18. Inspect—wash.
19. Mill slots.
20. Mill chip grooves.
21. Inspect—wash.
22. Burr threads.
23. Buff ends.
24. Inspect.
25. Blue.
26. Oil.

The first operation is performed on an automatic screw machine. The original bar stock is 29/32 inch in diameter.

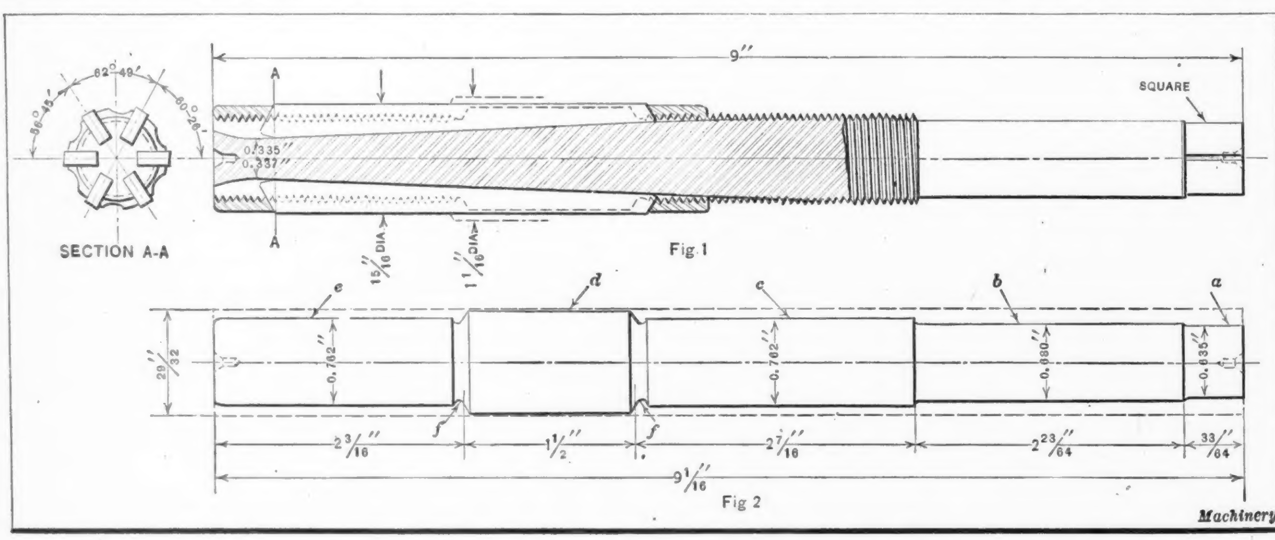


Fig. 1. Section of "Quick-set" Adjustable Reamer. Fig. 2. Appearance of Body of Reamer after Fourth Operation

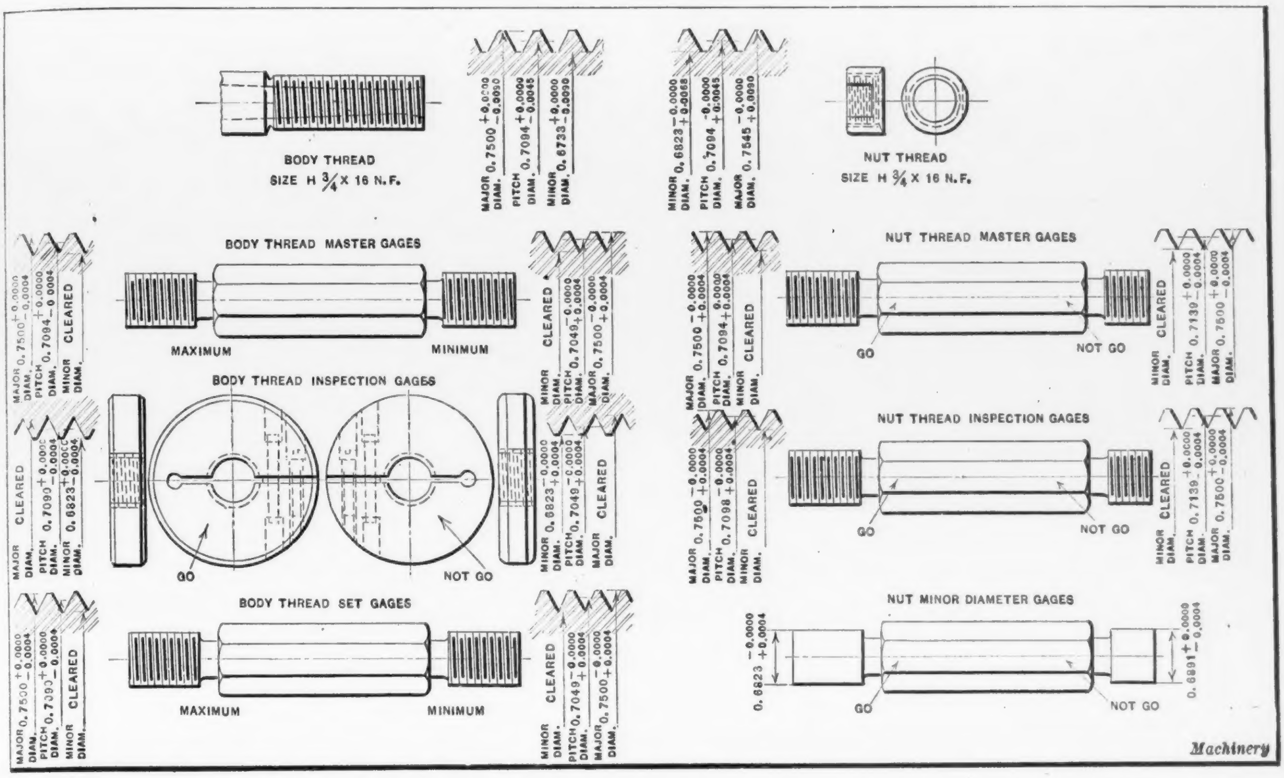


Fig. 3. Detailed Dimensions of Gages used in producing the Threaded Part of the Body and the Nuts of the Reamers

Referring to Fig. 2, the surfaces *a*, *b*, and *c* are turned to the dimensions given, and the piece is cut off. After the fourth operation, which is performed in a lathe, the piece has the dimensions shown in Fig. 2. The fifth and sixth operations consist in finish-turning *a*, *b*, *c*, *d*, and *e*, respectively, to the following dimensions: 0.623, 0.668, 0.750, 0.887, and 0.750 inch. These operations are done in a plain lathe, using a multiple toolpost as shown in Fig. 4.

The seventh, eighth, ninth, and tenth operations are not of special interest. The squares are milled by straddle-mills in a special fixture that can be indexed through 90 degrees. The recesses shown at *f*, Fig. 2, are to allow clearance for the threading hob. The squares are hardened in the usual manner. The surfaces *b* and *d* are then ground to the finished sizes 21/32 and ⅞ inch, respectively. The stamping is done on a commercial machine. The bodies are now ready for the seventeenth operation, in which the threads for the nuts are milled.

This reamer is undoubtedly one of the first products to be put on the market in which the threads are made in accordance with the "Progress Report" of the National Screw Thread Commission (Bureau of Standards, Washington, D. C.). The National Fine Thread has been adopted, which is based on the standard S. A. E. thread for sizes ¼ inch and larger. The size "H" reamer has a ¾ by 16 N. F. (national fine) thread. The basic diameters of this particular thread are as follows: Major diameter, 0.7500 inch; pitch diameter, 0.7094 inch; and minor diameter, 0.6688 inch.

In quantity production it is impossible to produce screws and nuts exactly to the dimensions given in the foregoing. To attain interchangeable manufacture, the screws and nuts must be given tolerances such that economical production and satisfactory fits will be obtained. The National Screw Thread Commission has established various classes of fits (loose, medium, close, and wrench) with corresponding tolerances. In these reamers the medium fit is used (Class 2). Tolerances for this fit for the ¾ by 16 N. F. thread are as follows:

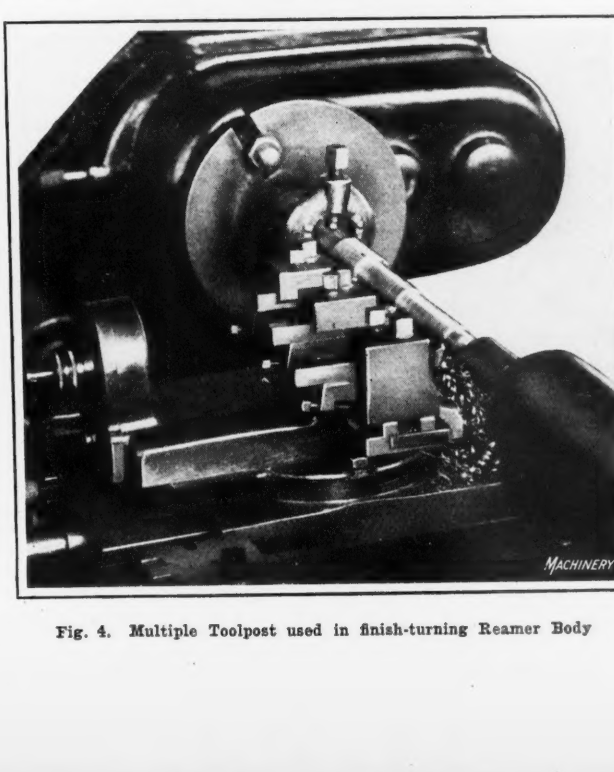


Fig. 4. Multiple Toolpost used in finish-turning Reamer Body

Screw Sizes

Major Diameter Max.	Major Diameter Min.	Pitch Diameter Max.	Pitch Diameter Min.	Minor Diameter Max.	Minor Diameter Min.
0.7500	0.7410	0.7094	0.7049	0.6733	0.6643

Nut Sizes

Major Diameter Min.	Major Diameter Max.	Pitch Diameter Min.	Pitch Diameter Max.	Minor Diameter Min.	Minor Diameter Max.
0.7545	0.7635	0.7094	0.7139	0.6823	0.6891

By the use of these tolerances, assurance will be had that any screw will enter any nut (provided there are no large errors in lead), and the smallest screw and largest nut will not give too loose a fit. The pitch diameter of the minimum nut is basic, with a plus tolerance, while the pitch diameter of the maximum screw has a minus tolerance.

To make sure that these tolerances on the body screw thread and the nut are maintained, the following gages are used:

Master Gages: Master threaded plug gages to represent the maximum and minimum thread on the body; "Go" and "Not Go" threaded plug gages for gaging the nuts.

Inspection Gages: "Go" and "Not Go" threaded ring gages for gaging the body threads; set or check threaded plug gages for each of the ring gages; "Go" and "Not Go" threaded plug gages for gaging the nuts; "Go" and

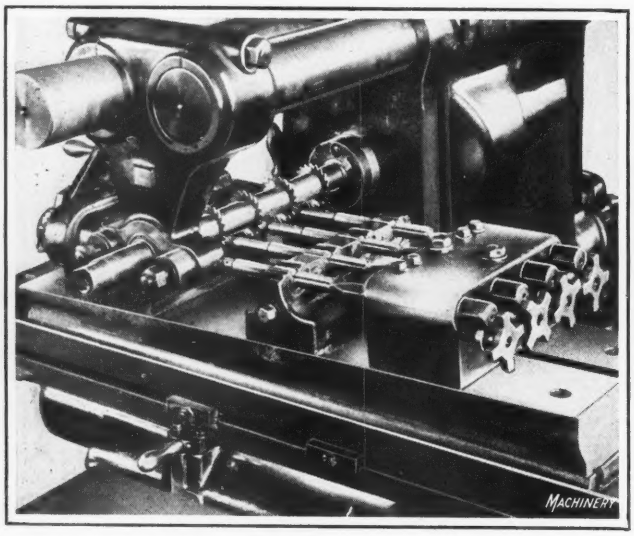


Fig. 5. Milling the Slots in the Reamer Bodies

"Not Go" plain plug gages for gaging maximum and minimum minor diameters of the nut.

Attention is called to the fact that gage tolerances and gage wear allowances are taken in directions that bring them within the limiting dimensions on the work. Fig. 3 shows the gages used, and gives the dimensions in detail.

The nineteenth operation—slot-milling—is the most important one performed on the bodies, as the accuracy of the tool is directly dependent upon the accuracy of the taper of the bottom of the slots, and upon the requirement that corresponding elements of the bottom of all slots must lie in a circle. The width of the slot must also be held within very close limits, as the blades must be a snug fit to avoid chatter. The operation is performed on plain milling machines and the set-up is shown in detail in Fig. 5. The fixtures rest on a taper platen permanently fastened to the table of the machine, and the reamers are held in gangs of four between centers. In addition to the centers, the reamers are supported by a rest on surface *d*, Fig. 2.

After the slot-milling operation is completed, each body is inspected for taper and concentricity of bottom of slots in the fixture shown in the heading illustration. A mandrel ground to the correct diameter and taper is used for setting the indicators. The mandrel is then taken out of the centers and each reamer body is tested in all slots. This fixture does not distinguish between errors in roundness and errors in taper, as in practice it has not been necessary to separate these, so far as routine inspection is concerned. If any slot shows a combined error in this fixture exceeding plus or minus 0.0005 inch, the body is rejected.

This high degree of accuracy is obtained only by the closest attention to detail in the manufacture of fixtures, and in the set-up and alignment of the machine. As four reamers are milled simultaneously, the cutters must be of exactly the same diameter and width. The cutters must be kept sharp and the arbors must run true. The separators between the cutters must also be true and accurate, as the cutters must line up with the centers of the fixtures. In addition, the fixtures must be kept thoroughly clean and free from chips. Any carelessness of the operator in regard to any of these details will invariably cause rejection of the finished parts.

In addition to being round and having the correct taper, the slots must be of the correct width. Each slot is gaged with a "Go" and "Not Go" gage. The slightest inaccuracy in the arbors, cutters, or separators is magnified in the slots and is sure to cause rejection, due to failure to pass the "Not Go" gage. The bodies are now complete, except for the finishing operation. As a rust deterrent, they are given a blue finish similar to rifle and small arms parts, followed by a final oiling.

Operations on the Nuts

The nuts for the size "H" reamer are shown in Fig. 6. The manufacturing operations on these parts are as follows:

1. Drill.
2. Tap.
3. Chamfer.
4. Cut off.
5. Inspect.
6. Finish-tap.
7. Face for length.
8. Form radius.
9. Inspect.
10. Mill flats.
11. Finish-chamfer and burr.
12. Wash.
13. Burr ends.
14. Inspect.
15. Caseharden.
16. Test for roundness.
17. Blue.
18. Oil.

Operations 1 to 4 inclusive are made on 15/16-inch bar stock in automatic screw machines. Operations 6, 7, and 8 are performed in one setting on a screw machine. Operation 10 is performed on a plain milling machine in the fixture shown in Fig. 8. Operation 11 is important, as the chamfered surface of the nut bears on the ends of the blades, and must be so aligned with the threads that the nut will have equal bearing pressure upon the six blades. It has been found by experience that the first rough-chamfering operation (No. 3) on the automatic machines is not sufficiently accurate. In order to secure this accuracy, the nuts are threaded for finish-chamfering on an arbor corresponding to the "Go" thread gage. Following the finish-chamfering, the ends are burred, after which they are inspected. The nuts are then casehardened and finished in the same manner as the body.

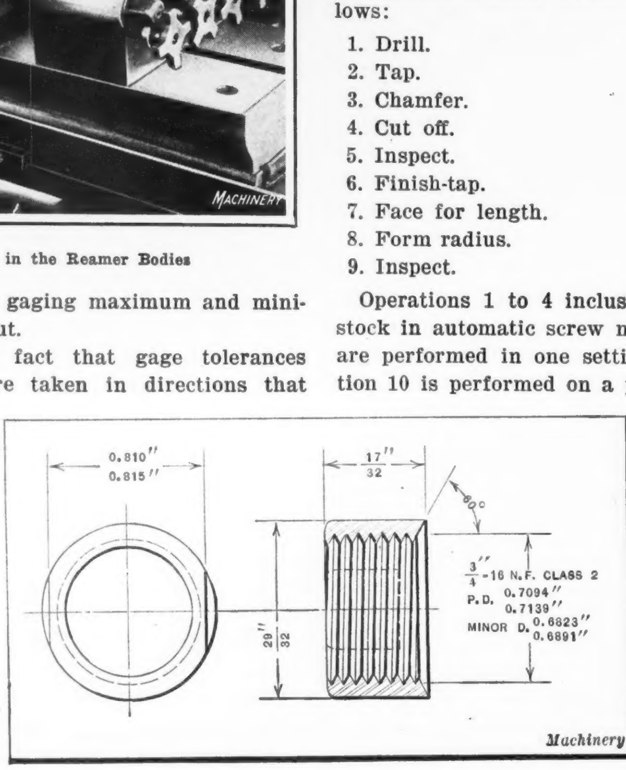


Fig. 6. Nut used for Adjustable Reamer

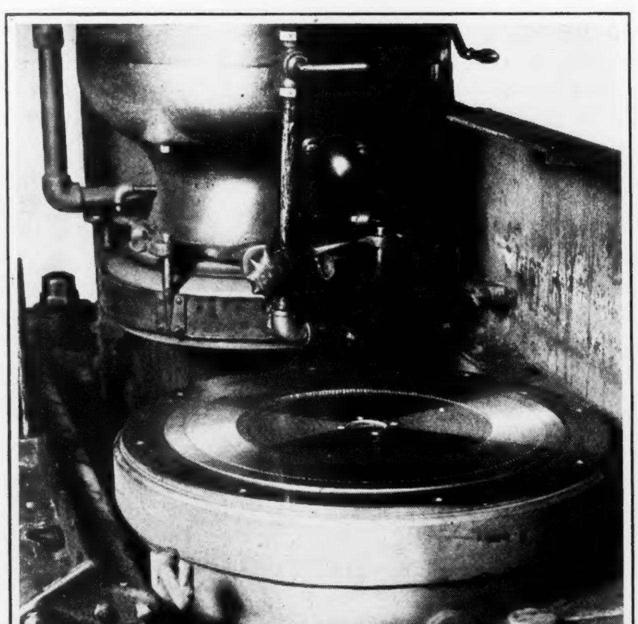


Fig. 7. Grinding the Sides of the Blades

Operations on the Blades

The finished blade for the size "H" reamer is shown in Fig. 9. In the case of the larger sizes, such as the "H" size, the blades are cut from bars having a cross-section approximating that of the longitudinal section of the blade. The smaller sizes are punched from sheet stock; otherwise the operations are the same. The stock from which the blades are cut is a high-grade carbon tool steel. The various operations on the reamer blades are performed in the following sequence:

1. Mill plates.
2. Cut blades.
3. Harden.
4. Inspect.
5. Straighten.
6. Grind sides.
7. Grind the top and the bottom.
8. Grind clearance angle.
9. Demagnetize.
10. Grind bottom edges.
11. Wash.
12. Inspect.
13. Grind to length.
14. Bevel bottom corners.
15. Wash.
16. Inspect.
17. Oil.
18. Finish-grind.
19. Inspect.
20. Stamp.
21. Oil.

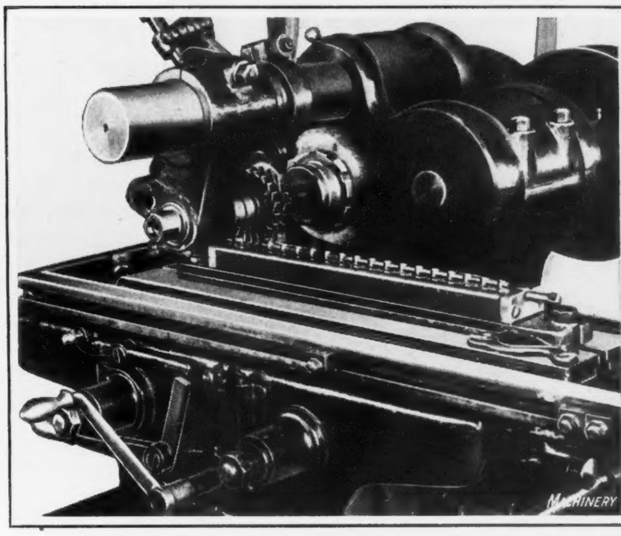


Fig. 8. Milling the Flats on the Nuts for the Reamer

The first operation consists of straddle-milling the edges of the rolled bars so that the width of the bar becomes approximately 0.018 inch more than the finished length of the blade. The second operation consists of sawing the bars into blades, leaving about 0.020 inch of stock for grinding. This work is done on a plain milling machine with a gang of forty-three saws, so that forty-two blades are cut at each pass. The third operation consists of hardening the blades, after which they are tested individually for hardness.

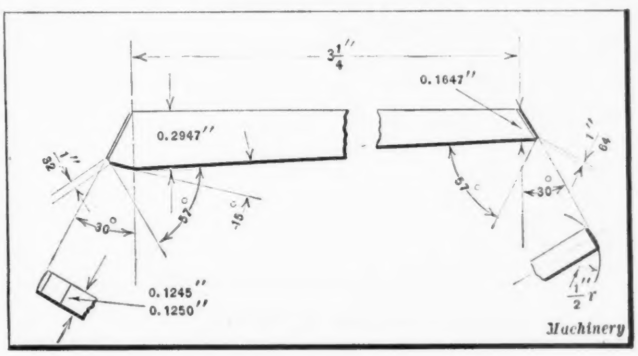


Fig. 9. Dimensions of Finished Reamer Blade

After straightening, both sides are ground in a vertical surface grinding machine to limits of + 0.000 and — 0.001 inch. In this operation, about 180 pieces are handled at one time. Fig. 7 shows the operation in detail. The blades are then clamped in a fixture (shown in Fig. 10), and are rough-ground on the top and finish-ground on the bottom (Operation 7). This operation is also performed on the vertical grinding machine used for the sixth operation. The blades, while still in the fixture, are then transferred to a grinding machine of the type shown in Fig. 10, for grinding the clearance angle.

The ninth, tenth, eleventh, and twelfth operations are simple. The thirteenth operation—grinding to length—is one of the most important, as if the blades are not of the same length, they will not be clamped equally by the nuts, and one or more blades will be loose in the reamer. The tolerance on this operation is ±0.0005 inch. The remaining operations are self-explanatory, and will be understood by referring to the list given in the foregoing. After finish-grinding, the blades are divided into sets of six and stamped serially in sets so that any given set of blades can be identified at any future time.

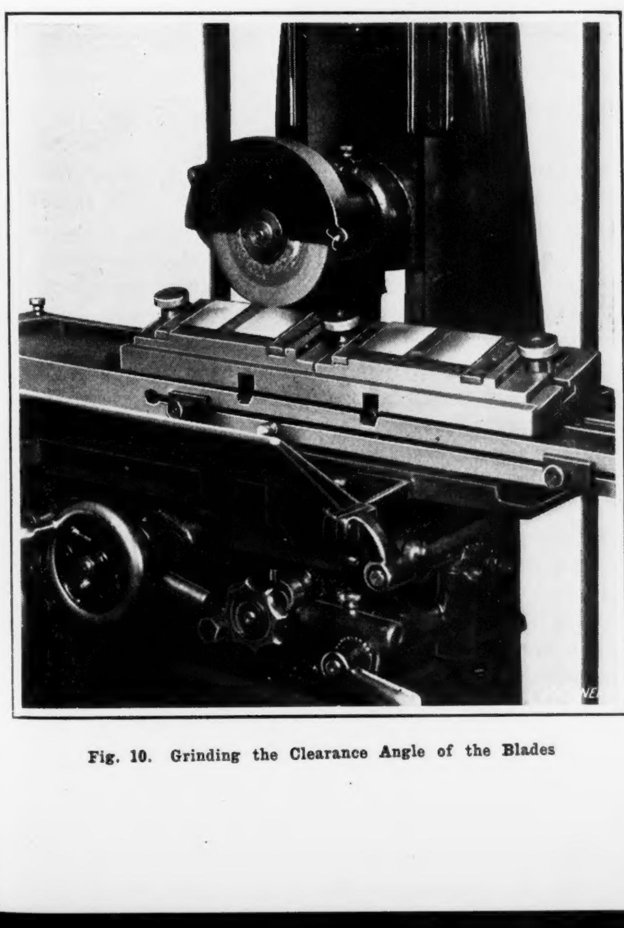


Fig. 10. Grinding the Clearance Angle of the Blades

The result of the operations, as explained, is that all nuts and bodies are completely interchangeable. Sets of blades are also completely interchangeable. In the final assembly, no selection of parts is necessary—that is, the blades are placed in the bodies at the time of final assembly, the nuts are screwed down and the reamers are ready to cut. The only requirement is that the utmost cleanliness be observed. Any blade fits any slot, but due to the division of the blades into sets after grinding for length, it is not claimed that any blade in one set is interchangeable with a blade in another set, but all blades in the same set are completely interchangeable. It is not claimed that this type of tool can be compared for precision with a solid hand reamer of standard construction. It is, however, a tool exceptionally well adapted to general garage work, and is most useful in the repair department in any plant.

Adjustment of Reamer

In adjusting a reamer from one size to another, the greatest care must be taken to see that the slots are free from dirt or chips, as any foreign substance lodged under a blade will cause it to project beyond the true circumference of the reamer, resulting in chattering, and preventing adjacent blades from cutting. The nuts should be set up to a snug fit, but should not be too tight. In the hands of a skillful mechanic, the tool is capable of great precision, but if dirt and chips were allowed to accumulate under the blades it would not be dependable.

TAPPING FIXTURES

The accompanying illustrations show two novel fixtures for multiple tapping. These fixtures are used in connection with a special multiple-spindle tapping machine capable of threading right- and left-hand threads simultaneously. The parts tapped form the upper and lower plates, respectively, of a small meter. The lower plate has eight holes to be tapped within a circle having a diameter of 1¾ inches, and the top plate has two holes about ½ inch apart, one having a right-hand and the other a left-hand thread. The multiple-spindle head for tapping the lower plate was arranged with two groups of spindles, spaced 1⅝ inches apart, since the distance between the centers of some of the spindles was only ⅛ inch, which precluded any possibility of arranging the spindles in one group. As the travel of the table carrying the fixtures up to the tapping spindles was very short, some provision for loading the fixtures at a position not directly under the tapping head was necessary.

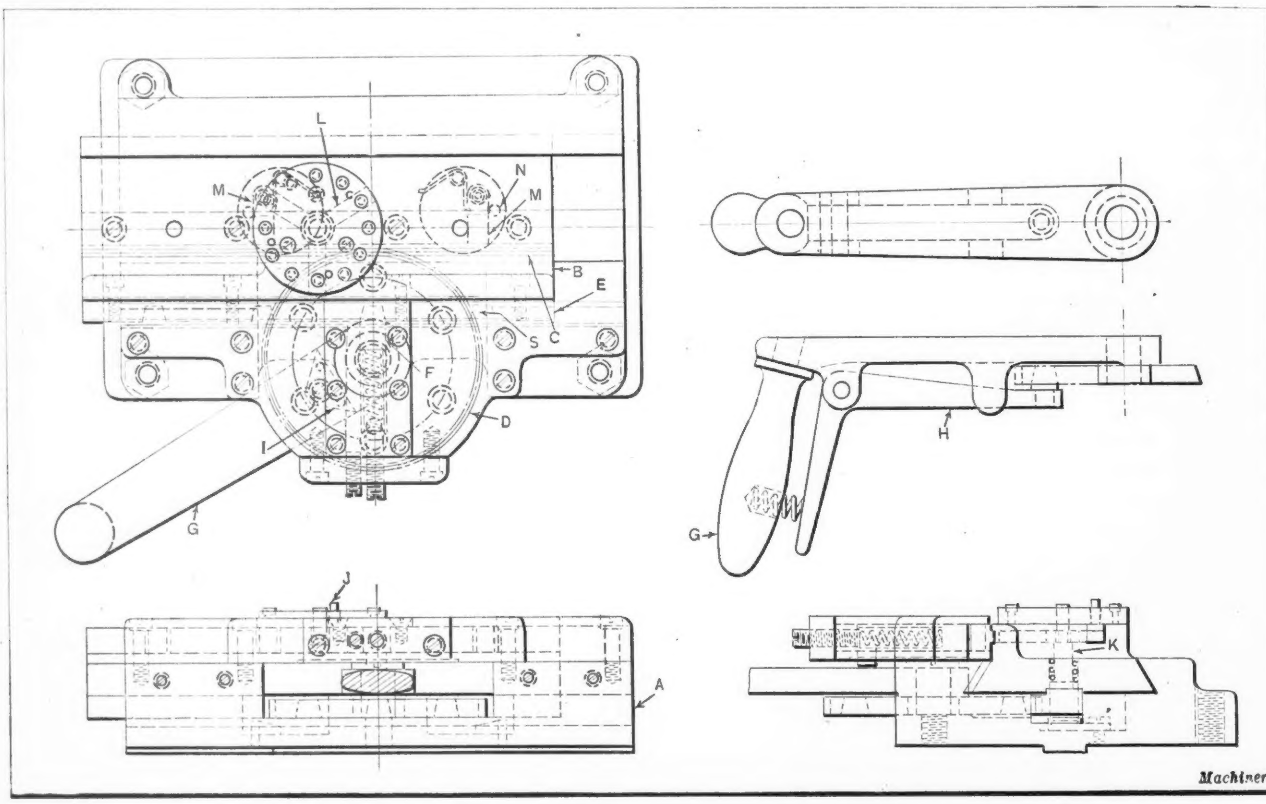


Fig. 1. Fixture used in performing Multiple Tapping Operations on the Lower Plate of a Meter

The fixture shown in Fig. 1 was evolved to solve the tapping problem for the lower plate. This consists of a base *A*, bolted to the tapping machine bed, and a dovetail slide *B*, carried by the base and provided with locating pins and an ejecting mechanism. Attached to slide *B* is a rack *C* which meshes with the index-gear *D*. An indexing strip *E* having four notches which are engaged by the locking bolt *F* in the base is also secured to slide *B*. The indexing gear is engaged by the handle *G* at the time of indexing.

As may be assumed from the illustration, there are four stations—two loading and two machining or tapping stations. Starting at the left-hand side, we have first the loading station, second the tapping station for one group of holes, third the tapping station for the remaining group of holes, and fourth the unloading station. The arrangement is such that the fixture does not have to be returned to the first station for reloading, this operation taking place at the fourth station. The slide carrying the plate is then indexed back from right to left in the operation of tapping the next plate.

The indexing is accomplished by the handle *G* through a trigger finger *H* which engages holes in the indexing gear *D*. When the indexing handle is at the central position, cam-plate *I* disengages locking bolt *F* from the notch in the strip *E* attached to slide *B*. Now by permitting the trigger finger *H* to engage the hole in the indexing gear, the slide can be indexed either to the left or to the right until locking bolt *F* drops into another notch in strip *E*. Thus if it is desired to index slide *B* to the extreme left position from the position shown in the illustration, trigger finger *H* would simply be depressed to disengage handle *G* from gear *D* and bring the handle to the central position in order to unlock or withdraw pin *F*. Now by releasing trigger finger *H*, so that handle *G* will engage gear *D*, the handle can be swung to the extreme right-hand position so that pin *F* will drop into the index notch at *S*. Starting with the handle *G* at the central line, three similar movements to the left will bring slide *B* to the extreme right-hand position.

The arrangement of the indexing mechanism is such that one hand only is required for indexing, so that the other hand is left free for loading and unloading. The feeding movement of the table is controlled by a foot-treadle. A cut-out arrangement on the machine stops the movement of the table at the end of the feeding stroke. The meter plates are provided with three working holes which are used for locating the work in all manufacturing operations. The fixtures are therefore provided with three locating pins *J*, which naturally would slow up the tapping operation in so far as loading and unloading is concerned, particularly if the holes in the plates are a tight fit on the locating pins. An ejecting device was incorporated, which consists of a simple plunger *K* carrying a three-armed spider *L*. The arms of the spider reach out to the ejector-pins placed adjacent to the locating pins.

Normally the three ejector-pins are held down or depressed due to the action of the spring on the central plunger. As the slide moves toward the right from the third to the fourth station, and to the left from the second to the first station, the central plunger pushes one of the pivoted cams *M* over until it backs against one of the pins *N*, at which position the cam causes the ejector-pins to rise and strip the work from the locating pins. By the time the slide has reached the first or the fourth station, as the case

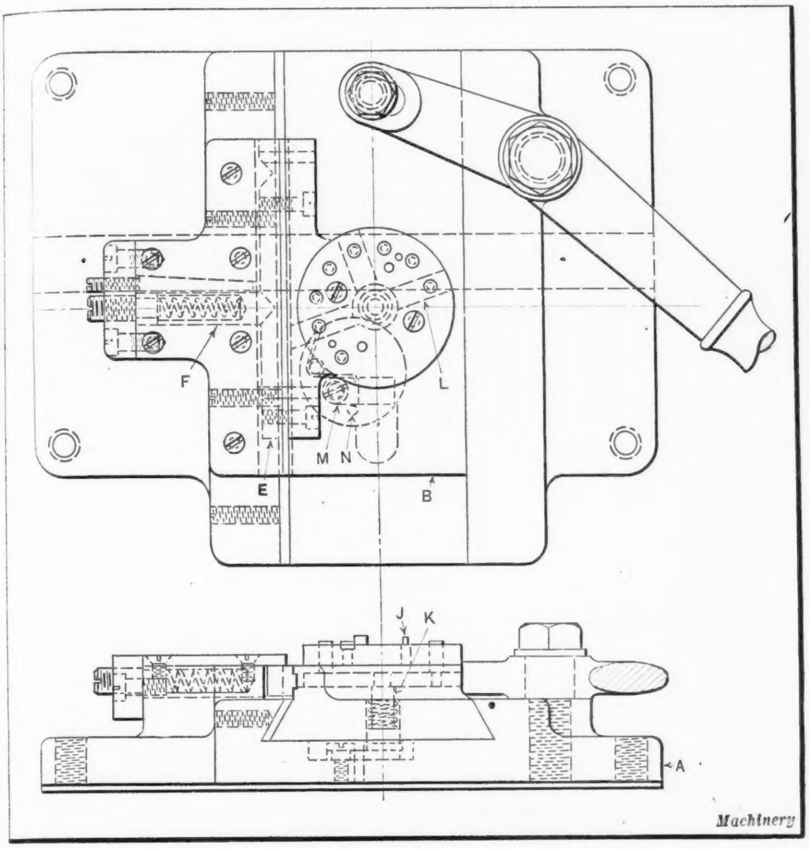


Fig. 2. Two-position Fixture used on Multiple Tapping Machine

may be, the plunger has dropped down in back of the pivoted cam. This movement causes the ejector-pins to assume their normal position so that they will not interfere with the loading operation. On the return motion the cam pivots or is turned back, allowing the central plunger to pass without raising the ejector-pins.

Considerable speed may be obtained by the use of fixtures such as the one shown in Figs. 1 and 2. The same type of fixture can be used for drilling operations as well as for tapping. If the spacing of the slide indexing strip is correct, a stationary overhanging plate can be fastened to the fixture to carry the guide bushings for the drills.

The fixture shown in Fig. 2 was designed for use in tapping the top plate, which has but two holes, one having a left-hand thread and the other a right-hand thread. Only two stations are used in this case, namely the loading and the tapping station. The indexing mechanism was simplified somewhat, in this case, a lever and link being used in place of the indexing gear. The locking bolt *F* was milled to an angle or point, and while it normally holds the slide securely in position, it is readily withdrawn by the pressure exerted on the indexing lever when moving the slide from one position to another. The ejecting device is the same as that shown in Fig. 1. B. G. C.

* * *

The railways of the country took approximately 22 per cent of all of the rolled steel manufactured in the United States in 1922; buildings and other construction work took 15 per cent; automobiles, 10 per cent; oil, gas, water, and mining, 10 per cent; agriculture, 4 per cent; food containers, 4 per cent; exports, 7 per cent; and all other uses a total of 28 per cent.

PIERCING, FLANGING AND BLANKING DIE

By P. BALDUS

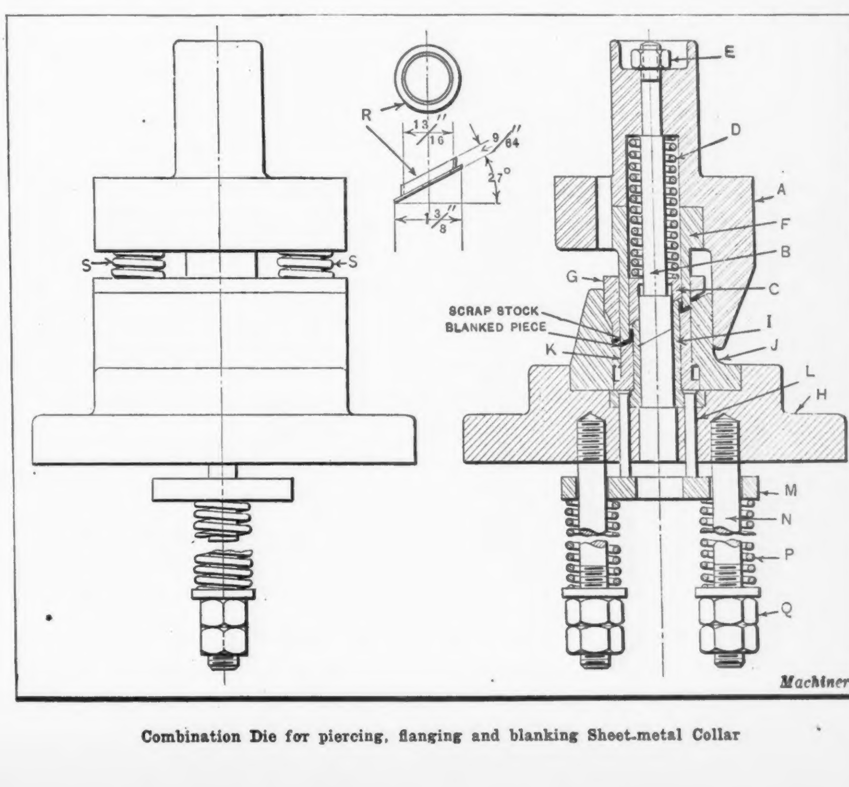
The combination die shown in the accompanying illustration is designed to pierce, flange, and blank the collar shown at *R*. This collar, which is of rather an unusual shape, forms part of the gasoline tank of a motorcycle. It is made from strip tin stock, 1 9/16 inches wide and 0.020 inches thick, which is fed through the die at an angle of 27 degrees, as indicated by the sectional view of the die.

The punch-holder *A* is made of machine steel and carries the piercing punch *B*, which is fitted with a stripper *C*. The stripper is operated by the compression spring *D*. Punch *B* is held in place by a hexagonal nut *E*. The drawing and trimming punch *F* is screwed into a counterbored hole in punch-holder *A*, and locked in place by a dowel-pin. The stripper *G* is operated by two compression springs *S* shown in the front elevation view. The piercing punch, stripper, and the drawing and trimming punch are made of tool steel, and are hardened and ground to exact size. Cast iron is used for the die-holder *H*.

The piercing and drawing die *I* is held in place in the die-holder by the trimming die *J*, which is secured by means of 1/2-inch fillister-head screws. A knock-out *K*, operated through pins *L*, ejects the finished piece from die *J*. The piercing and drawing die, the knock-out, and the trimming die are all made of tool steel, and are hardened and accurately ground to size. The knock-out pins *L* and studs *N* are made of cold-rolled steel. Pressure is transmitted to pins *L* through plate *M*. The tension of the two compression springs *P* can be adjusted by means of hexagonal lock-nuts *Q*.

* * *

Not less than eighty different types, or different makes of the same type, of electric furnaces have been used, tried, or suggested for melting copper, brass, or bronze, aluminum or nickel alloys. Descriptions of these different types of furnaces are contained in Bulletin 202, issued by the Bureau of Mines, Washington, D. C.



Combination Die for piercing, flanging and blanking Sheet-metal Collar

DESIGN OF MACHINE ADAPTERS

By H. P. LOSELY, Industrial Engineer, Detroit, Mich.

Adapters are used for so many different purposes in the shop that it is of advantage to have one man in the tool-designing department attend to the ordering and assigning of all adapters, as well as the drawing of new ones. This man need not be an expert tool man although he must be acquainted with the general run of work and machines, and must be rapid and systematic. He should maintain a card index of all adapters, making a separate card for each adapter which will show its main characteristics and where it is being used; this card should be filed by number. Besides this, a card should be kept for each machine, and on this card should be listed all adapters fitting that machine.

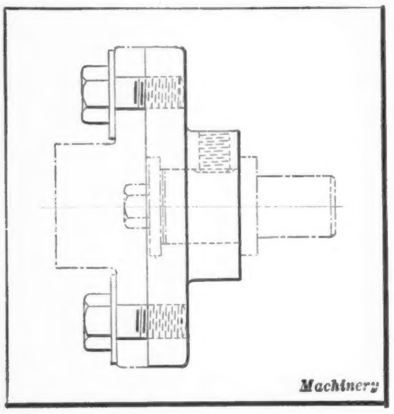


Fig. 1. Faceplate Adapter which has no Projections

Then when an adapter is wanted for any purpose, it will be easy to determine from the machine list whether a suitable adapter already exists; if so, the drawing should be looked up to make sure that it is exactly what is required. The adapter card might also be looked up to see if it is available. If it is, it can be listed as assigned to the required job. When new adapters are required they should be drawn to scale and listed in the card index. It is important that the index be kept strictly up to date, as it will then require little time for upkeep, and, by saving a great deal of adapter duplication, will help to keep down the amount invested in equipment. It will also prevent wasting time in waiting for new adapters when old ones are available.

Fig. 1 illustrates a common type of faceplate adapter in which the freedom from any projections will be noted. The screw heads are located behind the faceplate, and a safety type of set-screw is used to prevent the arbor from turning. The screws have sufficient clearance in the faceplate holes to permit truing the adapter with an indicator. The type of adapter commonly used with chucks is shown in Fig. 2 at *A*. Most chucks attached by fillister-head screws have the tapped holes in the chuck body. When cap-screws are provided, the adapter is, of course, made with plain holes instead of counterbored ones, and in cases where the screws are put in from the jaw side of the chuck, the adapter must be provided with tapped holes.

It is useful to have "dummies" made to match the spindles of those lathes that are frequently fitted with adapters, as this saves a great deal of trouble in the tool-room; the machinist can turn up and thread an adapter at one setting, testing the thread and the pilot hole with the dummy. Otherwise, he is obliged to try the adapter on the machine, and since the adapter must be left in the chuck until completed, this procedure necessitates dismounting the chuck of the tool-room lathe each time the adapter is tried on the spindle of the machine. Often the assistance of a helper is required. Not only is the whole procedure laborious, but there is also a chance for the adapter to be mounted slightly out of true when the chuck is put back on the tool-room lathe.

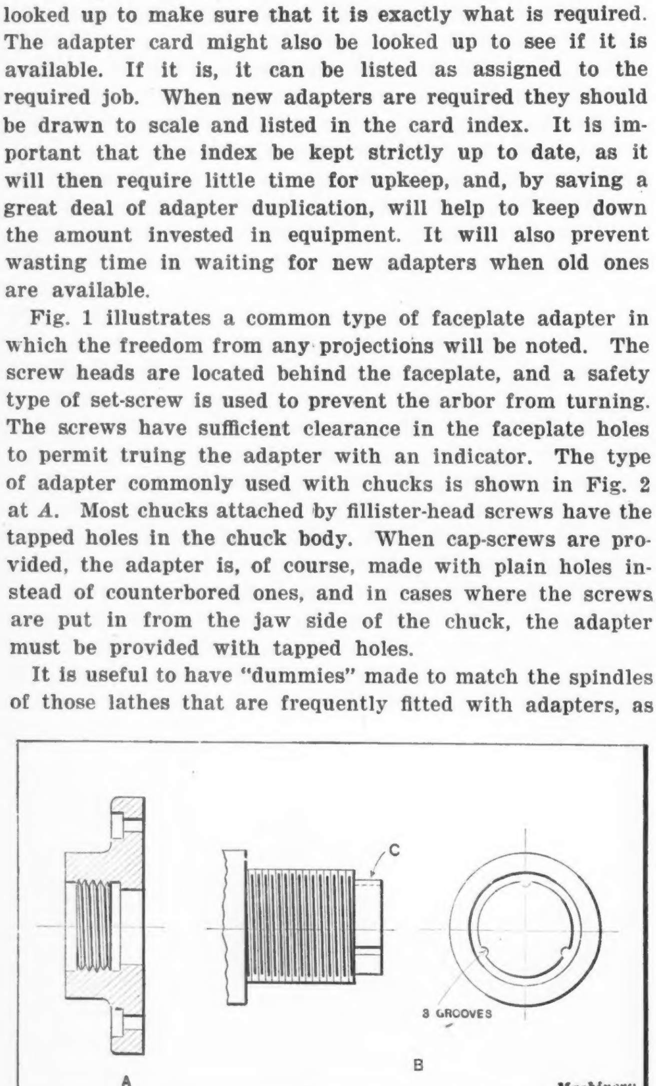


Fig. 2. (A) Type of Adapter used in Connection with Chucks; (B) Lathe Spindle Pilot provided with Dust Grooves

An examination of a large number of lathe spindles shows that the nose *C*, in the view *B*, Fig. 2, which serves as a pilot and should be smooth and true, in the great majority of cases is pitted and grooved after a comparatively short term of service. It is the opinion of the writer that lathe manufacturers should always provide dust grooves on these pilots, as indicated. It is inevitable that small chips will get into the adapter, and when the latter is put on the spindle, these chips are rolled into the metal of the pilot and gradually ruin its accuracy. The grooves suggested would pick up these chips and so preserve the spindle. When a new lathe is bought, it would be of advantage to have such grooves provided before putting the lathe into use.

An adapter, for mounting an end-mill on a milling machine is illustrated in Fig. 3. The body of the adapter is attached to the machine spindle by means of four fillister-head screws, the drive being through two tongues *A*. The cutter is slotted on the face and is driven by the two keys *B*, which are rounded to fit the milled slots in the adapter. However, they might just as well be straight and so save the extra expense of rounding the ends. The cutter is piloted on the nose of the adapter and drawn down tight against the face by means of the special screw *C*. This screw is plugged by disk *D* to prevent chips and cutting compound from getting into the spindle. The same result could be secured in a cheaper way if a square-hole drill were available by drilling the hole only half way through.

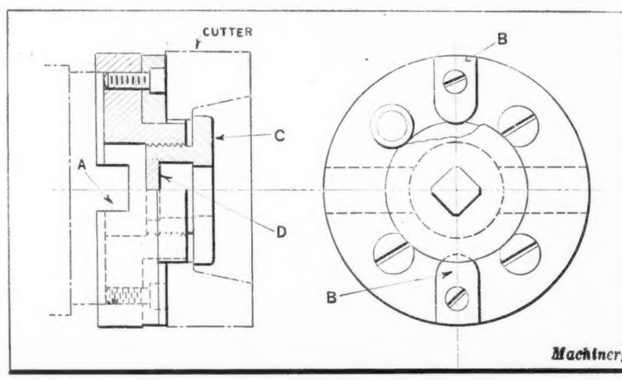


Fig. 3. Construction of an Adapter for attaching a Cutter to the End of a Milling Machine Spindle

* * *

IMPROVEMENT IN STEEL CASTING BUSINESS

The steel casting business improved very much in 1922, the sale of commercial castings in that year being almost three times as large as in 1921, and at almost the same level as in 1920. This estimate is based on reports from sixty-five companies comprising over two-thirds of the commercial steel-casting capacity of the United States, the reports having been made to the Bureau of Standards in cooperation with the Steel Founders' Society. The railways were heavy buyers of steel castings during the past year. The business done in 1922 was equivalent to nearly 70 per cent of the steel casting capacity, as compared with less than 25 per cent in 1921.

BUTTON METHOD OF CHECKING ANGULAR WORK

By W. G. HOLMES

In checking the angular surfaces of jigs and fixtures, it frequently happens that the large size of the work, or the impossibility of removing the angular part to be tested, makes it desirable to do the checking by some process other than by the usual sine-bar method. For cases of this kind the button method here described has proved satisfactory. By using two buttons having a difference in diameter of from 1 to 2 inches, quite accurate results may be obtained. Referring to Fig. 1, it is required to check the angular location of surface *NP* in relation to the surface *MP* of the surface plate, or in other words to check the accuracy of angle *e*. The line *MNS* is perpendicular to the surface plate, and may represent either the edge of a square or the side of a parallel which is clamped to the piece. In clamping the square or the parallel to the work, considerable care must be taken to see that the surface *MS* is in a truly vertical position or at exactly right angles with the surface *MP*. Careful shimming is often required in order to obtain this condition.

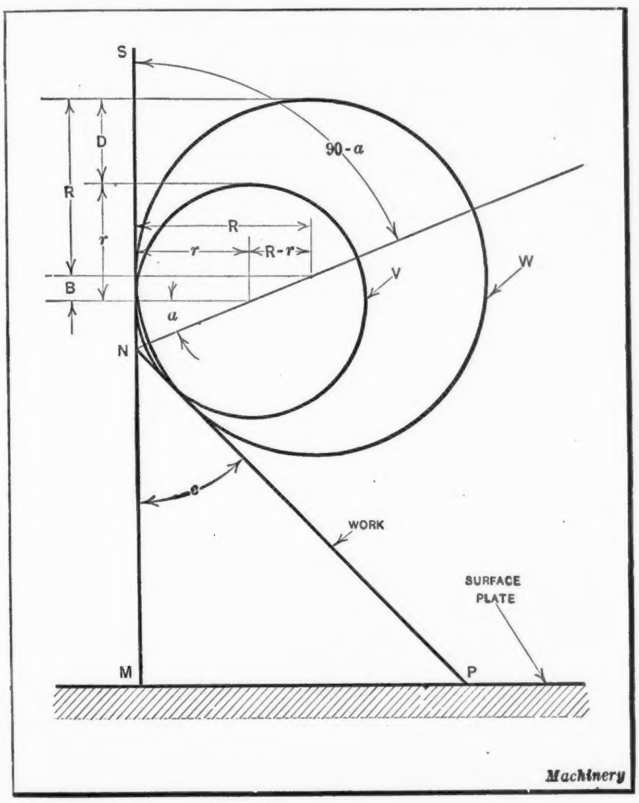


Fig. 1. Button Method of checking Angular Work when the Angle is Less than 90 Degrees

The button *V* is placed in contact with the side of the parallel and the side of the work in the angle *SNP* and a measurement taken over the top of the button with a height gage. The same procedure is also followed with respect to button *W*. By subtracting one reading from the other we obtain the difference *D*. We now have given:

r = radius of button *V;*
R = radius of button *W;* and
D = difference in the measurements taken over the two buttons.

From the values given it is required to find angle *e*, or the angle which the top face of the work forms with the vertical line *SM*. When angle *e* is less than 90 degrees, the solution is as follows:

In Fig. 1, we have:

$$a = 90 \text{ degrees} - \frac{180 - e}{2} = \tfrac{1}{2}\, e$$

$$B = (R - r) \tan a$$

$$D = R + B - r \quad \text{or} \quad D = R - r + (R - r) \tan a$$

Transposing

$$(R - r) \tan a = D + r - R$$

Hence

$$\operatorname{Tan} a = \frac{D + r - R}{R - r} \quad \text{and} \quad e = 2a$$

When angle *e* is more than 90 degrees, as shown in Fig. 2, the solution would be as follows:

By geometry we have

$$a = \frac{180 \text{ degrees} - e}{2}$$

and by trigonometry,

$$B = (R - r) \cot a$$

Now

$$D + r = R + B \text{ or } D = R + B - r$$

By substitution we now have

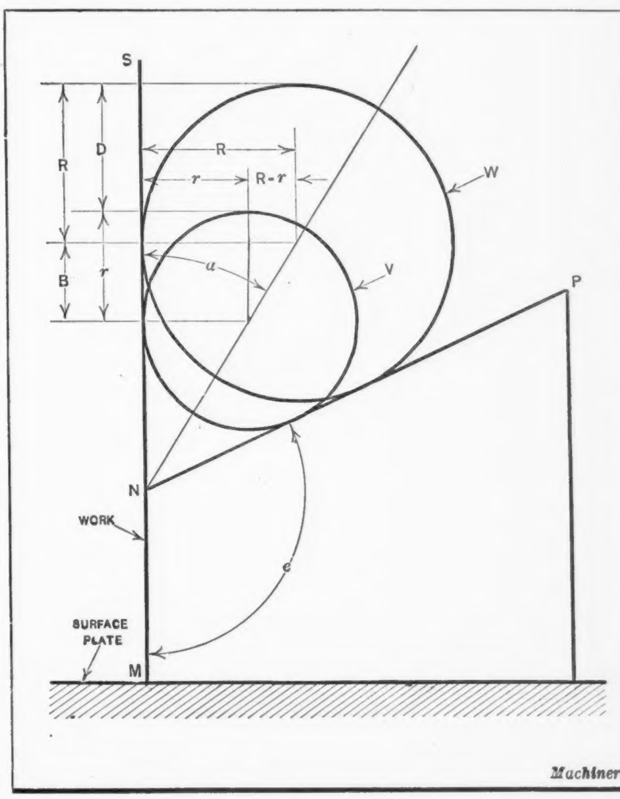


Fig. 2. Method of using Buttons to check Angular Work when the Angle is Greater than 90 Degrees

$$D = R + (R - r) \cot a - r$$

Transposing

$$(R - r) \cot a = D - R + r$$

Hence

$$\operatorname{Cot} a = \frac{D - R + r}{R - r} \quad \text{and} \quad e = 180 - 2a$$

* * *

NEW APPLICATION FOR STEEL CASTINGS

Bronze is generally thought to be the only material suitable for church bells, but experiments made in Bohemia indicate that bells cast from Siemens-Martin steel give practically the same tone as bronze bells of the same size, and are lighter in weight. This matter is of particular importance at the present time in Germany and the former Austrian territory, because most of the church bells were melted down during the war, and the question now arises how to replace them by metals less expensive than bronze. The steel castings for the bells are turned, and are then rustproofed.

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THE AUTOMOBILE INDUSTRY'S FUTURE

There have been so many surprises in the automobile industry that it would be venturesome to prophesy its future course. But there are two different opinions voiced among men directly and indirectly connected with this industry that are worth recording for the guidance of manufacturers in the general machine-shop equipment field.

According to one opinion—an optimistic, and yet, in the light of past automobile history, a conservative view—the industry will continue to operate in the future at practically the present output, with possibly a slight increase. Those who hold this opinion claim that while the 1922 production was about 2,400,000 cars, fully half of this was replacement business, and in the future the replacement of worn cars by new ones will be even greater than now, in proportion to the total business. As the automobile becomes more of a necessity and a business adjunct, rather than a luxury, the market for it increases.

The other opinion, also expressed by men whose past judgment in automobile affairs has been frequently verified, is that if the production and sale of new cars proceeds at its present high rate, an increasing number of old cars must be taken by dealers in trade, and soon the second-hand market will be so glutted with cars that the sales of new automobiles will be seriously interfered with. Those holding this opinion expect this condition to make itself felt seriously enough to influence production schedules in automobile factories in about six months, and are advising the buying of materials and parts with that possibility in mind.

We do not undertake to say which view is correct, because there are various arguments to support both; but it is wise to proceed with caution, and not to load up with too heavy stocks of materials or finished products in anticipation of a continued high-pressure automobile production. On the other hand, a slump in the automobile industry is not within the probabilities; the general prosperity of the country insures a steady and moderate increase.

For the past fifteen years we have repeatedly heard that the automobile market has finally become saturated; but the builders of cars always have found ways of increasing their sales and the field to which they appeal has constantly broadened. Early in 1921, it was believed that if in the following two years the industry did a business of from 50 to 75 per cent of that for 1920, it would do well. In 1922, a year later, the sales exceeded 1920 by 20 per cent.

* * *

THE SCARCITY OF SKILLED LABOR

The machine-building field in general, and the machine tool industry in particular, all over the country, is facing a serious shortage of skilled labor. There has been such a great industrial expansion during the last ten or fifteen years that the supply of skilled workers in the industry no longer is sufficient for its needs; and unfortunately there has been no systematic effort to maintain—not to mention increase—the number of all-around machinists and toolmakers. The apprentice system has survived only in comparatively few shops. Manufacturers may have been justified in ceasing to train young men in view of the difficulties of holding apprentices until their terms were completed; but the need for skilled workers makes the adoption of some form of apprenticeship imperative.

Evidently the training proposition does not offer sufficient inducement to young men for them to be willing to complete their terms of apprenticeship. The ease with which the unskilled worker can find a job to operate a machine that calls for little or no skill, constitutes the principal difficulty in holding the student until his training is completed. Imagine the effect upon the apprentice earning a comparatively small amount a week, who does not realize that his biggest compensation is the practical knowledge he is acquiring, when he meets a former schoolmate who earns two or three times that amount running a semi-automatic machine in an automobile plant. The apprentice does not fully realize that he is merely going to school, that he is fitting himself for greater responsibility and a better position in the industry than the other boy can ever hope to attain. The machine operator, as such, will always remain an operator, but his own ability and perseverance will set the only limits to the advance of the trained mechanic. Many great mechanical engineers of this generation, as well as thousands of our superintendents and works managers, were just ordinary apprentices twenty or thirty years ago, and the boys must be brought to a full realization of this fact if the apprentice method of training skilled mechanics is to succeed.

That it should succeed is imperative, or the supply of skilled workers will become so limited that the standing and progress of the machine-building industries will be imperilled. The problem of working out the details of a thoroughly successful apprenticeship system that will apply to all shops has not yet been completed; but the efforts of the National Metal Trades Association are certainly in the right direction and are likely to go far toward solving the problem, if adequately supported by its members.

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DON'T WASTE SALESMEN'S TIME

In a manufacturing plant in the Middle West, the following announcement is prominently displayed at the information desk: "Visiting salesmen will please insist upon receiving prompt attention. We, too, have salesmen whose time is valuable." If this method of dealing with salesmen were more general, what an amount of their time could be saved. A great deal of thought is given to saving time in the performance of machining operations, where much experimenting is required, followed by expenditure for special machinery; but why not also consider the wasted time of salesmen, who sometimes have to wait for hours to see the man whom they wish to interest?

A salesman must, of course, be willing to wait until the prospective customer finds it convenient to see him, but often he is kept waiting unnecessarily, particularly when after waiting a half hour or more, he is told there is nothing wanted in his line. If practicable, this information should be given without delay. It also will save the salesmen's time to make a practice of telling them about how long they probably will have to wait to see a certain person, so that they may have the choice of waiting or coming back. Often a salesman can put his time in profitably by calling on someone else in the interval.

Wonderful results have come from cooperative effort. Make this effort in your own plant, and like many unselfish movements, it may spread until it becomes a custom that will benefit you as well as others.

Standardization of Tap Thread Tolerances

What has been Accomplished Toward Standardization by Cooperation Among Manufacturers in the Tap Industry

About fifteen or twenty years ago several of the manufacturers of taps began to realize the desirability of a greater degree of standardization in the tap manufacturing industry. At that time there were no commonly accepted standards for the sizes of squares, diameters of shanks, lengths of threaded portion, or tolerances to be allowed on the tap threads. Gradually each tap manufacturer adopted a standard practice of his own, as far as the product of his shop was concerned, but taps made by different manufacturers at that time often varied considerably. This was recognized to be a disadvantage to both manufacturers and users of taps; but no means had been found up to that time to bring the practice of the many tap manufacturers of the country into uniformity.

It was not until after the formation of the Tap and Die Institute, comprising among its members the leading tap manufacturers of the country, that effective steps toward the adoption of standards that would apply to the practice of all the manufacturers could be taken. The first steps were to standardize such matters as the square, the shank, overall length, length of thread, etc., of the taps. The largest, most difficult, and at the same time most important item of standardization, however, was the tolerances for the pitch and outside diameters of the thread, and the lead of the thread. Various manufacturers, for inspection purposes in their own plants, had adopted tolerances and developed measuring instruments that made it possible to readily inspect the taps in order to ascertain that they were within these tolerances. But no two manufacturers employed the same tolerances for their entire product, and in some cases there were very wide variations.

Investigations Preceding the Standardization of Tap Thread Tolerances

About 1916 the first thorough investigation was undertaken by the Tap and Die Institute, as an organized body, with a view to determining what the tolerances employed by the different manufacturers were at that time on the commercial product regularly sold by them in the market. The object of this investigation was to record the commercial practice as it existed at that time, and to draw such conclusions as would make it possible to establish a commercial standard for tap thread tolerances that would be adhered to by all the tap manufacturers.

Having determined upon this investigation, it was decided to select some competent authority to carry out this work, which was probably the most extensive so far undertaken on any line of tools, aside from the investigation made by Frederick W. Taylor in his extensive experiments and research in regard to the art of cutting metal. Each of the tap manufacturers who were members of the institute sent to the authority selected to carry on the investigation fifty taps of each of twenty-one sizes, ranging by sixteenths from 1/4 to 1 inch, and by eighths from 1 1/8 to 2 inches. This meant that each manufacturer sent 1050 taps to be measured. For the several manufacturers this meant a total of 12,600 taps. The taps of each manufacturer were assigned a letter, so that as the measurements of these taps were made, they could be recorded on tracings and distributed without identifying the manufacturer by actual name.

One man was assigned to the work of measuring and recording the dimensions of the taps submitted, in order to insure complete uniformity in the measuring process. The work of measuring all of these taps required about four months, every outside and pitch diameter being recorded, as well as the error in lead per inch. The taps measured were all hand taps, and the record thus produced gave a most accurate idea, not only of the current practice at that time in this line of manufacture, but also of the commercial possibilities. Each manufacturer, when the investigation was completed, was furnished with a complete set of blueprints, showing the entire measurements. The identifying letter of his own company was furnished to him, but he was not able to identify the other companies. He could, however, compare his own product with that of all the others, and could determine whether, in some cases, his product was above or below the average. It is evident that even if the work had gone no further, this investigation would have stimulated every manufacturer to reach the highest standard indicated by any one tap maker, and would, in itself, have proved of great benefit both to tap manufacturers and tap users.

The Adoption of a Commercial Standard

Having undertaken the work of recording these measurements, the Tap and Die Institute concluded that this should be considered only the first step in the adoption of a commercial standard of tolerances that all the manufacturers would use. The results, as recorded by the measurements, were carefully studied, many meetings between the different manufacturers were held, and the principal users of taps consulted. It was found that many different conditions had to be met; for example, in certain taps the user wants a nut that will screw freely on the bolt, and he also wants a tap that will have a reasonably long life before it is worn down too small to produce acceptable nuts. This larger allowance permits a larger tolerance on the tap, which is also desirable from a commercial viewpoint.

The standards finally adopted as a result of this work have been published, as mentioned in December MACHINERY, in booklet form by the Tap and Die Institute, 116-120 W. 32nd St., New York City, and are available to all users of taps. They were adopted with a view to meeting the general average conditions in the trade, as indicated by past experience, and it is stated that 90 per cent or more of the requirements of the tap users are met by the standard tolerances that have been adopted.

There remains a small number of tap users who require tolerances smaller than those adopted as standard, but as no two of these users, as a rule, require the same tolerances, it has been found impracticable by the tap manufacturers to adopt any standards for these finer tolerances; but each case is considered special, and any taps required for purposes of this kind are made to order. There is also a growing demand for ground taps with exceptionally small tolerances, but compared with the total number of taps made, the output of ground taps is, as yet, quite small, and it was not considered necessary at this time to establish any standard tolerances for this small proportion of the product of the tap industry.

Tolerances for Different Kinds of Taps

In establishing the commercial tolerances, the requirements for different classes of taps were considered. For example, the tolerances established for hand taps are less liberal than those for tapper taps, in each case the practical requirements of the trade having been considered. The average requirements in the trade were taken as a measure of the most desirable

standard for commercial purposes, especially as taps meeting these requirements can be produced by the tap manufacturers at a commercial price.

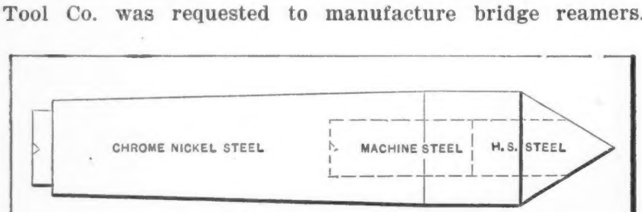
The result of this standardization is that the user knows what the manufacturer can produce and what he can expect to obtain in commercial taps. The manufacturer, in turn, has a definite standard to live up to, and as he knows that the user is cognizant of this standard, it becomes necessary for him scrupulously to meet its requirements. On the other hand, if the user's requirements demand finer tolerances than those obtainable in commercial taps, he will know that he must have these taps made to order as special, or must obtain ground taps. In other words, the object of this standardization, as of all other forms of standardization, is to obtain uniformity and simplicity. One general standard of taps to cover the very large percentage of requirements is most desirable for the tap manufacturers as well as the users, all other requirements to be taken care of as explained previously.

* * *

THE DEVELOPMENT OF HIGH-SPEED CENTERS

By THOMAS FISH, President, The Ready Tool Co., Bridgeport, Conn.

During the war, when all manufacturing concerns in the metal-working field were endeavoring in every way to assist the Government in regard to tool requirements, the Ready Tool Co. was requested to manufacture bridge reamers.



High-speed Center formed of Three Kinds of Steel

In order to produce the quantities required, it became necessary to make use of some lathes without taper attachments, and to set over the tailstock center to turn the long taper. From the very beginning there was a great deal of trouble due to the wearing down of the carbon-steel centers, and it was found necessary to grind them at least once a day and sometimes twice. In order to overcome this difficulty, an experiment was made with the use of high-speed steel centers. These centers, being made from solid high-speed steel, were, of course, very expensive.

When high-speed steel centers were used on the same machines and for the same work as the carbon-steel centers, they showed no signs of either burning or wearing after five weeks of hard usage, and as a result we definitely decided on their use in our own plant and made plans to put them on the market.

Experiments have shown that on lathe work at both high and low speeds the life of high-speed centers is easily ten times that of carbon-steel centers. In cases where the work is long and of fairly small diameter, when carbon centers are likely to burn off due to the expansion of the work being machined, the danger of spoiled centers and spoiled work seems to be entirely overcome by the use of high-speed steel centers. In grinding machines, high-speed centers also seem to stand the wear of the abrasive which gets into the cutting compound and which deteriorates the carbon-steel centers very rapidly.

One of the problems in substituting high-speed steel centers for carbon centers is the increased cost due to the higher priced material. But by welding the front or wearing end of the high-speed steel center to a chrome-nickel steel shank, an equally satisfactory center can be made at a much lower cost. Recently we have developed a center (for which patents are pending) as shown in the accompanying illustration. The object in designing this center was to reduce the first cost, especially in large sizes, and still retain all the advantages of a high-speed steel center.

The center consists of a chrome-nickel steel shank having a high-speed steel point. This point is welded to a machine-steel extension piece to provide an unusually deep seat in the shank and insure holding the point securely. The hole in the shank is reamed slightly tapering, and the point or plug is ground, after hardening, to the same taper as this hole.

In assembling the plug and shank, the latter is first heated to about 1100 or 1200 degrees F., and then the plug is forced into the hole under a heavy pressure, after which the shank is cooled by plunging it into cold water. As a result of this combination shrinkage and force fit, the plug or center is gripped very tightly by the shank, and it would be impossible to even locate the joint between them were it not for the slight variation in color between the high-speed steel plug and the chrome-nickel steel shank.

This construction is particularly advantageous for large centers, not only because of the saving in high-speed steel, but also because better heat-treatment can be applied to the smaller section of high-speed steel than was possible with the large ends that were formerly welded to the shank.

* * *

CATALOGUE INDEXES SHOULD BE COMPLETE

By N. G. NEAR

Many manufacturers publish catalogues that are inadequately indexed or have no index at all. Money may be spent without stint to secure the best paper and illustrations obtainable in getting out a catalogue, and the result may be very attractive in appearance, but too often it is disappointing from the practical viewpoint, because the information contained therein is not indexed for ready reference. The writer has often been obliged to make a time-consuming search in catalogues published by prominent manufacturers in order to locate the information desired, because the indexes were too general in nature.

In many cases the indexes are set up in large type, and they look as though an attempt has been made to use as few words as possible. It is well to be terse in certain descriptive matter, and in much advertising. The description that fully describes a thing in the fewest words is usually the best. In the case of an index, however, the manufacturer should not be stingy with words, but should use plenty of them and provide as many pages for the index as may be needed to make it complete.

In making catalogues it is too often the practice, if there is a page left open, to use that page for the index in some haphazard manner. Sometimes even when there is a page available, it is not used at all, and the catalogue is published without an index. The writer believes that some kind of index, even a poor one, is better than none at all. Again when the manufacturer notes that there is a spare page that can be utilized, instead of using it for an index, he sometimes inserts an illustration of some machine or product. The writer has often admired the indexes to be found in the catalogues of some of the large well-known mail order houses. These catalogues are very well arranged, and manufacturers and advertising men might well study the make-up of the indexes in these catalogues. They are certainly hard to beat for simplicity and completeness.

* * *

With a view to gaining experience in the latest developments of steam turbine practice in Great Britain, the Commonwealth Edison Co. of Chicago, has ordered a 40,000-kilowatt turbo-alternator from C. A. Parsons & Co., of Newcastle-on-Tyne, England. In 1912, the Commonwealth Edison Co. ordered a 25,000-kilowatt turbo-alternator from the same concern.

NUMBERING AND INDEXING DRAWINGS

By EDWARD HELLER

Nearly every mechanical engineer or chief draftsman has at some time been confronted with the problem of devising or improving a system for indexing and numbering drawings. While this problem is comparatively simple, when the work covered by the drawings is of one kind, it becomes greatly complicated when the work is of a varied nature. For instance, the methods used for numbering and indexing drawings of automobile parts are not entirely suitable for drawings of tools designed to machine those parts. Neither will a system devised for numbering drawings of structural work prove satisfactory for either of the cases mentioned. In fact, there is no system that will suit all purposes, but there is usually one good system that will meet the requirements of each particular case. The characteristics of such a system must be flexibility, simplicity of application, and expansibility.

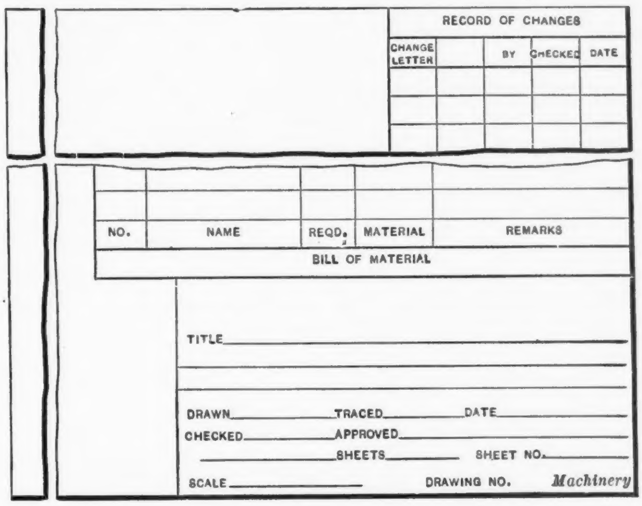


Fig. 1. Upper and Lower Right-hand Corners of Drawing Sheet

The system must be so flexible that it will readily include the different activities of the drafting-room or shop with a minimum of clerical work. When a new system is required to replace an old one, it must be so planned that it will be easy to change from the old to the new. If the cost of installing a new system is estimated to be more than will be saved in a reasonable length of time, by the new system, it is obvious that a change should not be made.

An important feature of a good system is the possibility of expanding it to include any new activities that may be under consideration. The writer was recently confronted with a problem of this nature, and as conditions were of a very general character, it was necessary that the system developed meet the requirements of many shops and drafting-rooms. The system was established in a large shop in northern Ohio devoted to the manufacture of an extensive line of aluminum and enameled steel utensils.

The drawings that required indexing included four general classes, namely, drawings of the product; drawings of tools; drawings of special machinery and equipment; and miscellaneous drawings, such as building and plant lay-outs. Of course, every drawing was numbered in some manner under the old system and the numbers recorded. A record was also kept of tools and patterns. The problem in this instance was made more difficult by the fact that a great many tools were made up in the tool-room without any drawings. Patterns for the replacement of broken parts were also made up in the pattern room without drawings of any kind. It was necessary, however, to keep a record of this work.

In the new system, standard sizes for drawings in multiples of 8½ by 11 inches are used. Each size is designated by a letter; thus, the 8½- by 11-inch size is given the letter A, the 11- by 17-inch size, letter B, etc. The title space in the lower right-hand corner of each drawing is made up as shown in Fig. 1. A space for recording changes is also provided in the upper right-hand corner as indicated.

Index Cards

After adopting standards for the sizes of drawings, the next problem was to design a suitable index card. The front side of the card finally developed is shown in Fig. 2, while the back of the card is shown in Fig. 3. It will be noted that sufficient space is allowed at the top of the card for the title. A space for the drawing number and other information is provided at the right of the title space.

The drawings are assigned numbers in the order of their completion. A card is filled out and a check mark made in the square on the line marked "Drawing." If the drawing happens to be a tool or piece of machinery, a check mark is also placed on the line marked "Tool." The drawing number also serves as the reference number for the tool or piece of equipment. If patterns are required for the job, a check mark is made on the line marked "Pattern." The drawing number with a letter added is used as the pattern number, and this is placed in the column headed "Pattern No." Thus, if the drawing is numbered 4372, the patterns for that job are numbered 4372-A, 4372-B, 4372-C, etc.

Record of Tools Made without Drawings

If a tool is made up in the tool-room without a drawing, the drafting-room is notified and a number secured for the tool. Numbers issued for tools made up without drawings are given out in consecutive order, just as though a drawing had been made. All the information necessary for filling out an index card is obtained at this time. In filling out the index card, a check mark is placed on the line marked "Tool," and also on the line marked "Pattern," provided patterns are used. In cases of this kind, the square on a line with the word "Drawing" is not filled in. This shows that no drawing has been made for the piece.

The same system in indexing and issuing numbers is applied to patterns that are made in the pattern shop without drawings. In this case, a check mark is placed only on the line marked "Pattern." The chief draftsman keeps a memorandum of such tools and patterns and in slack times has the drawings made up. When a drawing is made for one of these parts, the fact is recorded on the index card by placing a check mark on the line marked "Drawing." The order in which the drawings are completed is indicated by the letters representing the sheet sizes. Thus, A, C, B, A, indicates that sheet No. 1 will be found in the "A" size file, sheet No. 2 in the "C" size file, and so on.

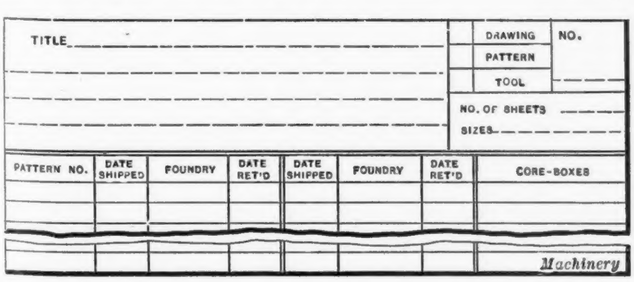


Fig. 2. Front Side of Index Card

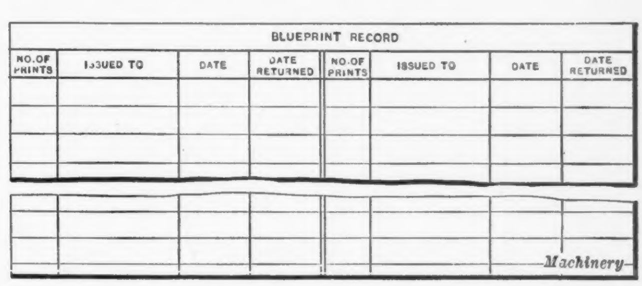


Fig. 3. Back Side of Index Card

The body of the card also has a space for the pattern record. In this particular plant the engineering department does all the ordering of castings and material or parts not kept in stock. When castings are ordered, a record is made on the card showing to which foundry the patterns have been sent, so that any pattern can be readily located by inspecting the index card file. When the patterns are returned, the receiving department notifies the engineering department so that the index card can be changed accordingly. When the space on one card becomes filled, another card bearing the reference number only is placed in front

TITLE ______________________________

DRAWING NO: __________

NAME OF PART						
MATERIAL						
PATTERN NO.						
SHEET NO.						
PATTS. ORDERED	DATE					
	ORDER NO.					
PATTS. RECEIVED						
CASTINGS ORDERED	DATE					
	ORDER NO.					
CASTINGS RECEIVED						
FORGINGS ORDERED	DATE					
	ORDER NO.					
FORGINGS RECEIVED						
TOOL OR JOB ORDERED	DATE					
	ORDER NO.					

Machinery

Fig. 4. Index Card of Alphabetical File

of the first card. Columns are ruled up on the back of the card, as indicated in Fig. 3, to provide for a record of blueprints.

Index Cards Arranged in Alphabetical Order

The index cards described are filed numerically, but in order to facilitate the location of a drawing, it was found necessary to have another set of index cards filed alphabetically. Considerable care must be exercised in making up the alphabetical card index. Many indexing systems that would otherwise be satisfactory are made confusing by an incorrectly designed alphabetical index. Usually the same kind of card is used for both files, although sometimes a card of a different color is used, with the same arrangement of columns and printing. This method, however, results in considerable duplication of the data contained on the cards, and thus increases the possibility of error.

To eliminate this trouble, an entirely different type of card was used for the alphabetical cards. The most prominent part of the card, as shown in Fig. 4, is the title space. The body of the card is designed for recording the progress of a job so that the engineering department can issue information to those concerned regarding the standing of the work at any time. The card is printed the same on both sides, thus providing space for records of at least ten parts. If more parts are needed on one job, another card is used. If a job requires castings, forgings, or other material not kept in stock, the card should be divided into several columns.

An important feature of the alphabetically filed card is that it shows definitely where a tool or piece of work may be found. Thus a forming die might be filed under "forming," or under "die," or, again, it might be filed under the part that the die forms. Usually it would be filed under the last-named heading, but in either case, definite information must be recorded, so that anyone will be able to locate the required drawing or part when needed.

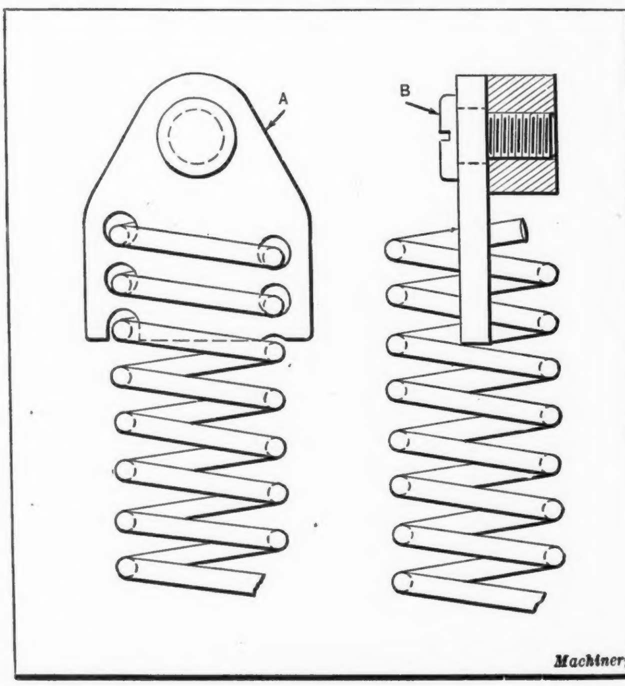
In a great many cases it is desirable to fill out cards and file them under various headings. The records are usually kept on the card that is most likely to be referred to, while the other cards bear only the title and drawing number with a reference to the fully filled out card written across their faces. One precaution must be taken, however, when filing more than one card for the same item, and that is to record that fact on the numerically filed card, so that in the event of a change being made in the title, all the cards can be readily looked up and changed. The few minutes spent in making out an extra card are often more than made up in time saved when a drawing or record is to be located.

A system of the kind described can be put into operation without interfering greatly with any system that is already in use. In placing the system in operation, the first number selected for the card index should be larger than any number used in the old system. If the drafting-room has a system employing numbers up to, say, 2500, the new system can start with 3001. Any drawing or tool bearing a number smaller than 3001 will at once be recognized as being recorded under the old system, while a drawing, tool, or pattern with a number above 3000 will be identified with the new system. Tools, patterns or other pieces that have stamped or cast numbers can be numbered under the new system when they become worn out, or undergo repairs, while drawings that do not involve such things can be changed at once. This method of changing from the old to the new system really amounts to the use of two systems instead of one for a time, but the change involves very little inconvenience or expense.

* * *

TENSION SPRING CONNECTION

Small and medium-sized tension springs usually have their end coils bent up parallel to the axis to form hooks, which are held by spring pins, eyes, or similar end connections. For heavy-duty springs, the stresses set up in the wire by bending the ends in this manner often make the method inapplicable. Under such conditions the device here illustrated has been found to give satisfactory service. It consists of a sheet-steel plate *A* having two rows of holes



Tension Spring Connection

spaced to conform to the diameter of the spring and the pitch of its coils. The end of the spring is simply screwed into these holes, and the stud *B* which passes through the plate prevents the latter from unscrewing. With this connection no undue stress is exerted on the spring at the point at which failure usually occurs. An additional advantage of this construction lies in the fact that the plate and its stud form a substantial bearing, which permits the spring to swing freely if the motion of the part to which it is attached tends to pull it out of line. P. R. H.

Standardization in the Industries

Various Aspects of Standardizing Mechanical Products, with Particular Reference to Small Tools

By CARL J. OXFORD, Chief Engineer, National Twist Drill & Tool Co., Detroit, Mich.

THE constantly increasing demand for low production costs has given a decided impetus to the movement to standardize manufactured products of all kinds. Standardization, as applied to mechanical products, may rightly be said to have originated abroad; but with the growing interest in this matter here, the time may soon come when we will outstrip our foreign friends. The establishment of the American Engineering Standards Committee (A. E. S. C.) marks an epoch in our industrial development. Reports covering the work of the A. E. S. C. are encouraging in that they show that standardization is being extended to wider and more varied fields from year to year.

To anyone who seriously has considered the subject, there can be no question about the desirability of standardization. The degree of desirability will vary, however, according to the kind of products considered. In some instances, absolute necessity has forced the issue, and standardization is an accomplished fact; in other cases, the necessity is less apparent, and as a consequence nothing has been accomplished. A uniform gage for railroad tracks, for instance, was early recognized as of paramount importance. In consequence, the standard gage is in universal use today.

Standardization of small tools is one of the important questions confronting our manufacturers today. Judging by the results of standardization, where such work has been undertaken, there can be no doubt about the gain resulting from it. The small individual savings will in the aggregate mean the saving of millions of dollars. It is therefore a matter that is worthy of interest and serious attention on the part of engineers, manufacturers, and consumers alike.

The Economic Importance of Standardization

Generally speaking, standardization would be justified only as a matter of convenience, but the real argument in its favor is the elimination of great economic waste. A case somewhat in point is cited from the great Baltimore fire. When it became apparent that the Baltimore fire fighters could not cope with the situation single-handed, a call for help was sent out to nearby cities. A great quantity of equipment was dispatched in response to this call. Upon arrival much of this equipment was useless, because the firehose couplings of other cities did not fit the pipe connections in Baltimore. The outside firemen were therefore compelled to stand idly by and watch the city burn. Through the energetic work of the National Board of Fire Underwriters and other agencies, standardization of hose couplings and connections has been effected to such an extent that today a greater portion of this equipment is uniform throughout the country.

It is difficult to interest anyone in a new movement while it is yet in what might be termed its abstract stages, especially if changes proposed involve the expenditure of money. Only by pointing out individual and public economic benefits can any measurable results be obtained. Educational work to promote standardization must therefore be directed along these lines.

The continued use of divergent standards for many manufactured products not only constitutes a national economic waste of enormous proportions, but is also a great danger to our ability to compete with foreign manufacturers in the markets of the world. It must be brought home to our own manufacturers and business men that in the standardization of their product with the consequent possibility of simple quantity production they have available the greatest competitive weapon ever afforded. Standardization must be applied both to the product they themselves manufacture and to the raw material, machinery, and tools used in the various manufacturing processes. With these thoughts in mind we will consider some of the questions involved in the standardization of the most universally used aids to mechanical manufacturing, namely, cutting tools.

Cost of Cutting Tools—an Important Item in Manufacturing

There is hardly a manufacturing establishment of any kind or size in which cutting tools are not used to a greater or less extent. In the strictly mechanical industries they are as necessary as raw material or labor; in the production of many articles the cost of the cutting tools closely approaches the cost of one or both of these items. It is, therefore, easily realized that the annual cost of cutting tools for the entire country represents a great many millions of dollars.

In the automotive industry alone, it is conservatively estimated that, on an average, one per cent of the gross sales price of every automobile represents the cost of tools used up in its manufacture. This may not at first glance seem a large amount, but when it is remembered that the annual sale of automobiles amounts to nearly two billions of dollars, it is seen that the cost of tools for this one industry alone is very great.

A manufacturer of a well-known type of mechanical equipment recently purchased a single milling cutter costing almost a thousand dollars. This cutter could perform only one of several machining operations on a stock part. While the tool cost for each of these parts is not definitely known by the writer, it is estimated that it might exceed one dollar for each piece produced. The above is cited as another illustration of the importance of cutting tools, and of their share in making up the net cost of finished articles.

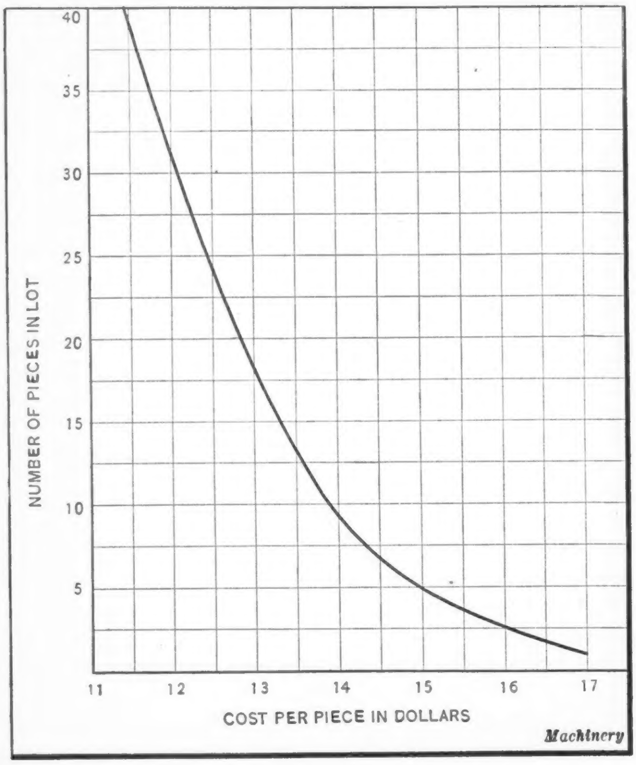
It is idle to speculate on ways and means of eliminating cutting tool costs, for as long as we are facing the necessity of cutting or separating materials of any kind, tools must be used. It is not idle, however, to bend our efforts toward the reduction of tool costs. Successful efforts in this direction will eventually mean lower costs of nearly all manufactured products. Lower tool costs will, for instance, mean lower-priced machinery. Whether this be textile machinery, steam engines, locomotives, electric motors, or automobiles, the cost of tools must eventually be absorbed by the public who purchase clothing, electric light, power or transportation of any kind. For it is very clear that the manufacturers of these commodities are compelled to price their product in proportion to their costs.

Great savings are possible through the proper handling and use of small tools. Instances of gross abuses of tools are so common that they are hardly conspicuous. Credit is due to efficiency engineers and others who have endeavored to correct this evil through educational efforts and improved methods. It is to be regretted that this work

can be extended only to a comparatively few of the larger manufacturing establishments. To accomplish results, a continuous effort is necessary on the part of those in charge. This is all too often lacking, because the advantages are seldom immediately apparent.

Savings due to Standardization of Small Tools

Still greater economies can be realized from the proper standardization of small tools. In some instances the tool manufacturer must take his cue for standardization from existing or proposed standards for other products. On the other hand, there are numerous cases where designers and manufacturers can profitably alter their designs and specifications to conform with such small tool standards as have been established. For example, if the gear manufacturers were to adopt as their standard only a few of the present pitches of gear teeth, then the obvious thing would be for



Relation between Cost and Number of Pieces manufactured

the tool manufacturers to arrange their standards for gear cutters and gear hobs accordingly. Both gears and tools could then be made in larger quantities of each size with a corresponding decrease in cost. Or, take the matter of tap drills. The American Screw Thread Commission has established a system of maximum and minimum diameters for tapped holes. The twist drill manufacturers are now in a position to establish standards for drills used in drilling such holes.

Keyway Cutters as An Example of Need for Standardization

A group of mechanical engineers recently in convention discussed the desirability of definite standard tolerances for keyways in shafts and holes, and corresponding standards for keys. If such standards were established, the keyway cutter manufacturers would be in a position to reduce these to practice by making cutters of a thickness which automatically would produce keyways within the desired limits. As matters now stand, the cutter manufacturers must make keyway cutters to the thickness specified by each individual consumer; and the latter's ideas as to the tolerances vary to a great extent. The following variations in thickness of cutters made for 5/16 inch keyways are from the files of a cutter manufacturer:

Maximum..........	0.3115	0.312	0.3125	0.313	0.3135
Minimum..........	0.3110	0.311	0.3115	0.312	0.3115

Obviously, the cutter manufacturers are unable to anticipate such varied requirements by carrying all the different sizes in stock. The proposition is further complicated by the fact that these cutters are ordered in various diameters ranging from 1½ to 4 inches in diameter. If they could be standardized to comprise only two or three sizes for one nominal size of keyway, then they could be made up in large quantities and carried in stock. Consumers could then purchase these cutters at approximately half the price, and in addition have the advantage of several sources of supply. Thus the benefit of standardization is twofold, affecting both producer and consumer.

The Designer's Part in Standardization

Designers could bring about the elimination of many existing sizes of tools if they would so arrange their designs as to use only a preferred list of sizes for holes and other finished dimensions. Shafts and other machine elements of any considerable size are usually designed with a sufficient factor of safety to permit appreciable intervals between successive sizes. Thus a shaft could be made either 2 or 2¼ inches in diameter, instead of using some of the sixty-fourth, thirty-second or sixteenth inch sizes between these figures. Six or seven sizes of drills and reamers now carried in stock by manufacturers could then be eliminated entirely, and the remaining sizes made in correspondingly larger quantities and at a much lower unit cost.

Not long ago the writer had occasion to point out an actual case where the cost of manufacturing a few special milling cutters proved to be 480 per cent higher than the cost of making standard cutters of approximately the same size. Needless to say the cost to the users of these cutters had to be based upon the expense of manufacturing. The difference in manufacturing cost will vary with the quantity manufactured in accordance with the curve shown in the illustration. The reason for this variation is fairly obvious; it is due to the fact that all overhead expenses must be absorbed by the number of pieces of each kind. Much of the overhead is the same, regardless of the quantity manufactured. If these charges are spread over several hundred pieces in one case, and over only half a dozen in another, the result is obvious.

Adapting the design of manufactured articles, and of jigs and fixtures, to the use of standard tools instead of special tools will often mean large savings to the consumer. Recently a large automotive manufacturer was prevailed upon to change a certain drilling operation so as to permit the use of standard drills. This change involved the virtual scrapping of about $3000 worth of tools, and the substitution of approximately $2500 worth of new equipment. Under the old method he bought special drills at seven dollars each, while he is now using standard drills at two dollars each. It is also found that a greater number of holes per drill is obtained with the standard drill than with the special one. The operation in question is one involving large quantities of parts to be machined and several dozen drills are used each week. It requires but simple arithmetic to find that the change was a profitable investment for him. Incidentally, he has also been able to reduce his inventory on this size of drill, because he can now purchase his requirements in the open market, as his production warrants. Similar instances could be recounted almost without end.

* * *

A census was taken on a much traveled New England highway in order to determine the average size of auto trucks and the speed at which they ordinarily traveled along the highways. Forty per cent of the trucks were of 1-ton capacity or under, and 33 per cent were between 1 and 2½ tons. Less than 2 per cent were of more than 5 tons capacity. Over 50 per cent of the trucks traveled on a level stretch of road at 20 miles an hour, and 37 per cent traveled at a higher speed.

Cutting Double Helical or Herringbone Gears

By FRANKLIN D. JONES

Duplex Type of Planer Used for Herringbone Gears of Large Pitch—Application of Gear Shapers and End-milling Process—Second of Two Articles

While most herringbone or double-helical gears are cut by the hobbing process, this method is not as practicable for very large pitches as planing on a machine of the templet or form-copying type. Some of the gears used in rolling mills, etc., have circular pitches ranging from 3 or 4 up to 8 or 10 inches, but the cost of the hobs required for such large pitches would be excessive and, in addition, a very heavy and expensive machine would be required to withstand the strain of hobbing. On the other hand, a planer of the templet or form-copying type using relatively simple inexpensive planing tools provides a very satisfactory way of cutting these coarse pitches.

Double-helical Type of Planer for Gears of Large Pitch

When herringbone gears are larger than, say, 3 inches circular pitch, a double-helical gear planer is used by the Fawcus Machine Co., Pittsburg, Pa., instead of a hobbing machine. Fig. 11 shows the cutting of cast-steel herringbone gears on a planer which has a capacity for gears up to 24 feet in diameter and is adaptable to spur gears as well as the herringbone type. This planer operates on the right- and left-hand sections of the gear simultaneously. It has two tool-heads which have reciprocating motions in opposite directions, the tools moving from the sides to the center of the blank while the latter is rotated through a small arc in order to produce the helical teeth. This machine is of the templet or form-copying type.

The carriage upon which the two tool-slides are mounted is adjustable along horizontal ways to suit the diameter of the gear. This machine is very flexible in regard to the range of diameters it will accommodate, as indicated in Fig. 12, which shows the cutting of a relatively small herringbone pinion. The two tool-heads *A* and *B* (Fig. 11) carry planer tools of the usual form, no special shape of cutting edge being required. On the side of each tool-slide is a templet or former *C*, which controls the path followed by the tool as it feeds inward, thus producing teeth of the right curvature.

The tools cut from the outer edges of the gear blanks toward the center and in a horizontal plane. In conjunction with this planing movement, the gear blank is rotated for forming the helical teeth by a rotating mechanism consisting of change-gears and a worm meshing with worm-wheel *D* connected to the main spindle. For gears larger than 9 feet in diameter, a faceplate is used having herringbone teeth cut in the periphery, and an auxiliary drive is provided in connection with worm-wheel *D* to insure a smooth rotating movement.

When the tools reach the center of the blank and reverse for the return stroke, the gear also rotates in a reverse direction. When the tools reach the bottom of the tooth, the cutting operation is stopped automatically. After each tooth is machined, the tools are withdrawn and the work indexed for planing the next tooth. This indexing movement is transmitted through the large worm-wheel *E*; it is derived from a small motor and controlled by a push-button.

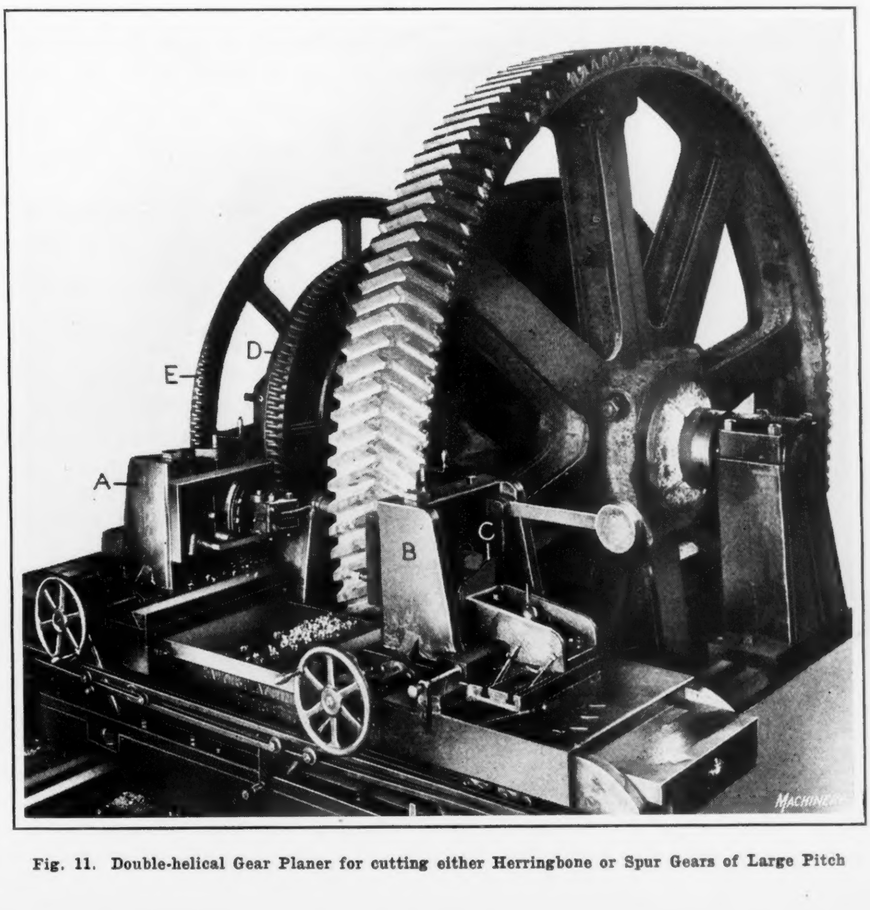


Fig. 11. Double-helical Gear Planer for cutting either Herringbone or Spur Gears of Large Pitch

The rotating movement applied to the gear while planing, as well as the power for driving the planing tools, is derived from a reversible motor. Trip-dogs on the tool-slides control the stroke through an electric switch and a controlling apparatus. This machine is used for planing steel pinions from the solid as well as for finishing cast teeth. The latter may have the teeth cast to within say, 3/8 to 1/2 inch of the finished size. For herringbone gears, a tool clearance of about 2 inches is required at the center for all pitches. The teeth may be connected at the apex or center (see Fig. 11) in order to give additional strength, in which case tool clearance is provided by coring the teeth below the finished surfaces at this point. When gears are cast solid, tool clearance is obtained by turning a groove at the apex 2 inches wide and slightly below the full depth of the teeth.

Cutting Herringbone Gears on a Gear Shaper

When a Fellows gear shaper is used for cutting herringbone gears, a narrow clearance space equal to about one-half the depth of the teeth may be used. The pull stroke is first used to cut one-half of the teeth on all of the blanks in a lot. Then the cutter and the helical guides of the machine are changed for cutting teeth of the opposite hand or inclination. The machine is also adjusted to cut on the push or downward stroke.

Fig. 13 shows a gear shaper cutting the upper section of a herringbone gear. Instead of using one machine for finishing both sides, two machines may be utilized, in which case gears are cut on one side in one machine and are then transferred to the other for finishing the opposite side. This method is adapted to quantity production. The cutting of a herringbone gear by this method must be done carefully in order to obtain accurate right- and left-hand sections in proper alignment. If the mating pinion is not free to float, greater accuracy is necessary in the alignment of the teeth than where the pinion can float. When the rows of teeth on both sides of the gear are in alignment with each other, the term "matched herringbone gear" is sometimes used to distinguish between this form and the "staggered herringbone gear." Methods of cutting both of these classes of gearing on the Fellows gear shaper will now be considered.

Aligning Matched and Staggered Herringbone Gears

In cutting matched herringbone gears it is evident that some means must be provided for securing proper alignment of the teeth. One method is illustrated in Figs. 14 and 15. It consists in making two master gears, one right-hand and the other left-hand. These master gears are of the same diameter, thickness, pitch, and helix angle as the gears to be cut, and can be made from cast-iron blanks. A spacing washer of the same thickness as the clearance groove in the gears to be cut is also made and placed between the master gears, after which the two gears and spacing washer are placed on an arbor. Now the advantage in making these masters in two pieces is that they can be set in the proper alignment with each other and then be bolted or doweled together; they are then used in setting the cutter for cutting the second part of the herringbone gears.

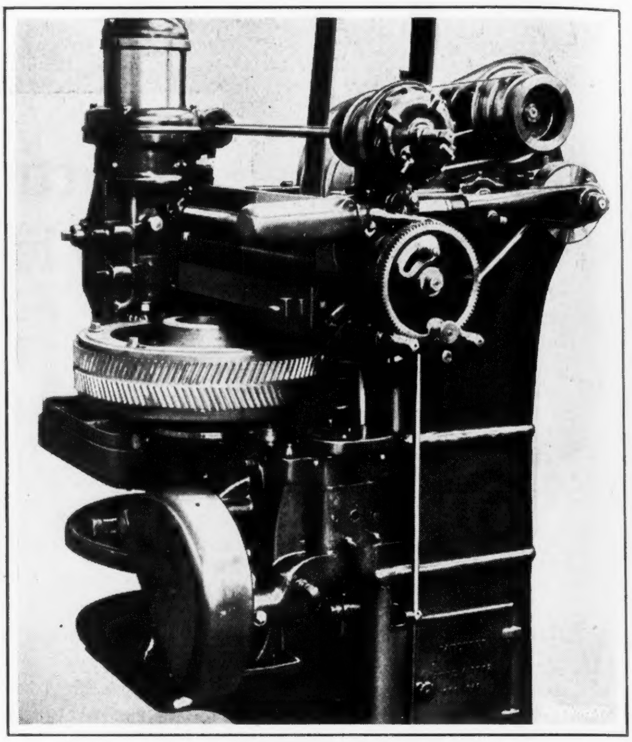


Fig. 13. Cutting a Herringbone Gear on a Gear Shaper

Before explaining how the cutter is set, the adjusting of the two master blanks to align the teeth will be explained. The apparatus includes a V-block *A* placed on a surface plate, an arbor *B* on which the gears are held, and two straightedges *C* and *D*. Rectangular block *E* is forced into the space between the two rows of teeth, and straightedges *C* and *D* are secured to the block by means of a clamp.

With the straightedges balanced on the tops of the teeth, if the teeth in the two gear blanks are not in alignment with each other, these two straightedges will not be parallel, as illustrated on an exaggerated scale in Fig. 15. To determine when the teeth are set parallel to each other, a dial indicator is used. The straightedges are balanced on the tops of the teeth, so that they can be clamped very lightly and the gears adjusted so that the straightedges are parallel. Then the gears are clamped or doweled together and serve as masters for setting the cutter.

The method of aligning master staggered herringbone gears is similar to that just explained, with the exception that the teeth of one side must be in alignment with the spaces of the other side. This necessitates cutting a notch in one of the straightedges, as shown in Fig. 16, so that it will straddle the tooth on the gear which must be in alignment with the tooth space on the opposite gear. This arrangement brings the straightedge on one gear lower than the straightedge on the other gear, so that the

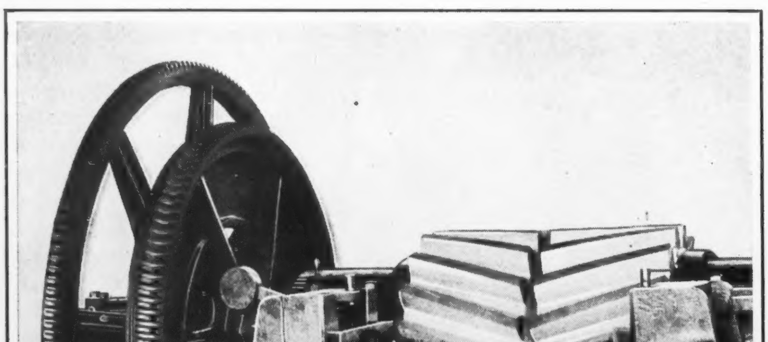


Fig. 12. Cutting a Herringbone Pinion on a Double-helical Planer

Fig. 14. Aligning Master Gears which are used for setting Gear Shaper Cutter before cutting Second Half of Herringbone Gear

problem is to get the straightedges parallel with the surface plate. When this is done, the rows of teeth are staggered relative to each other, and in correct alignment.

Cutting the Gears

After the masters are made, the next step is to cut the gears. First, the teeth on one side of the blank are cut to the proper depth. No particular setting of the cutter relative to the work is necessary for this side, as far as the alignment of the teeth is concerned. For cutting the other side, some sort of a locating fixture is used. This fixture *A* (see Figs. 17 and 18) is clamped to the work-spindle and trued up. Then the master gear is placed on the fixture, and the locating pin *B* is brought into contact with the teeth of the lower gear, after which the gears are clamped.

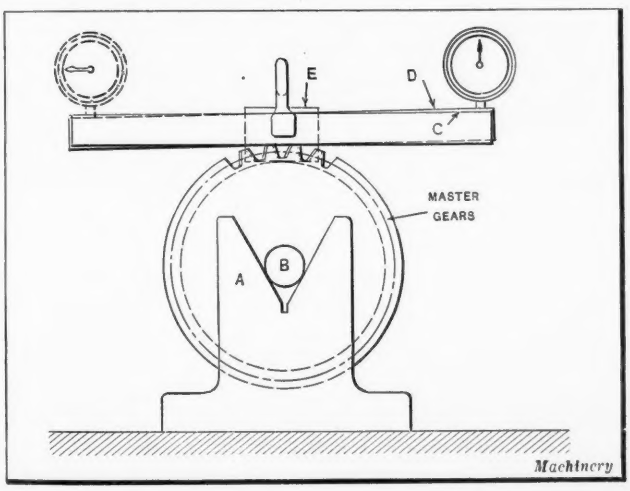


Fig. 15. Diagram illustrating Method shown in Fig. 14

The cutter is then placed on the cutter-spindle and left free to be rotated by hand. A wrench is next placed on the rack screw, which is exposed by lifting guard *A*, Fig. 19, and the cutter-slide is moved until the cutter is in alignment with the teeth of the top section of the master gear. The pitch dial is rotated with a crank-wrench placed on shaft *B*, until the locating pin *C* drops into place. The apron must also be closed, as will be seen by observing the position of the apron-locking plungers at the rear of the machine. The crank-wrench is now placed on the pinion-shaft *D* of the saddle, and the cutter is advanced toward the work; at the same time the cutter is moved on the spindle so that the teeth of the cutter and the teeth of the gear can be brought into mesh. When the cutter has been fed in to the proper depth, and is in correct alignment with the teeth, the nut on the cutter-spindle is tightened.

The cutter has now been set so that the row of teeth in the unfinished half of the blank can be cut in alignment with the row of teeth already completed, and to the same depth. The pitch dial is next set to the proper pitch, and in so doing, the cutter is backed away from the work, permitting the removal of the master blanks and the substitution of the gears to be cut. The locating pin, which is used for aligning the gears, must be a good fit in the bushing of the fixture, and care should be exercised in clamping the blanks to see that this pin is not forced back. In making these adjustments, either the matched or staggered master gears are used, according to the type of gearing to be cut. Accurate methods of aligning one-piece triple gears, consisting of a herringbone and spur gear combination, will be found in December, 1919, MACHINERY, page 309.

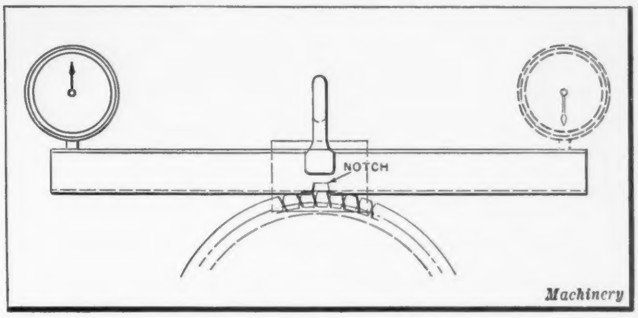


Fig. 16. Arrangement for aligning Staggered Herringbone Gears

Cutting Internal Herringbone Gears

Fig. 20 shows a gear shaper cutting an internal herringbone gear. As there is quite a large recess below the teeth, it is possible to cut the lower section first by using the pull stroke, and then cut the upper section by employing the push stroke. This is the general practice when the design of the gear will permit. The lower end of the gear casting has an internal flange, which fits over a projection on the faceplate and centers the gear. A large washer, in conjunction with the regular work-arbor at the center, is used for clamping the gear blank to the faceplate.

Cutting Herringbone Gears by End-milling

Herringbone gears are sometimes cut by the end-milling process, although this method is not as commonly employed

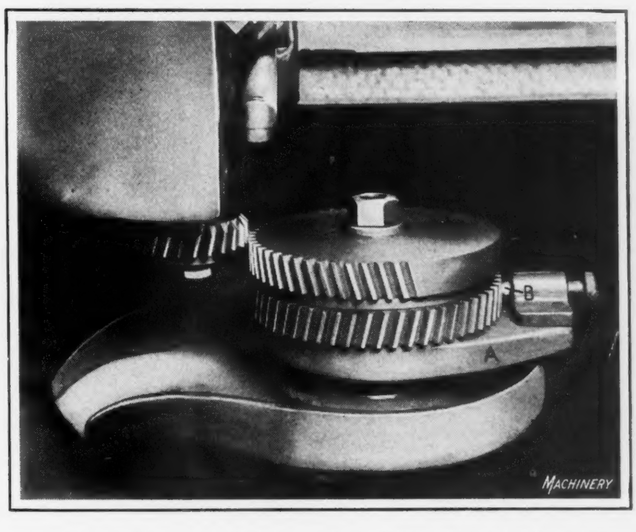


Fig. 17. Locating Fixture used in cutting Second Half of Herringbone Gear

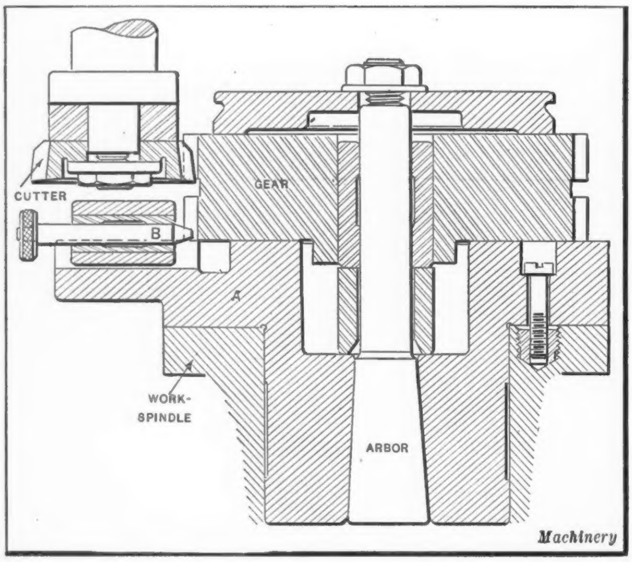


Fig. 18. Locating Fixture Similar to Type shown in Fig. 17

as hobbing and planing. One design of machine using an end-mill has a horizontal cutter-spindle located at the same height as the center of the gear, which is supported by a horizontal work-spindle. The cutter is carried by a slide which feeds horizontally, while the gear blank is revolved at a rate depending upon the helix angle of the teeth.

An end-mill type of machine operating in this way, used at the plant of the Woodard Machine Co., Wooster, Ohio, was described in detail in September, 1921, MACHINERY. It is the general practice to use this machine for gears up to about five inches circular pitch, and to plane the teeth of larger gears. When the teeth are formed by end-milling, all the teeth on one side of the gear are finished first, and then the teeth on the opposite side are cut. When cutting the first half, the cutter feeds in to the center of the gear face; then it returns rapidly through the milled space, after which the gear is indexed for cutting the next tooth space. When one half of the gear is cut in this manner, the cutter is moved to the other side, the feeding movement is reversed, and the operations are repeated.

When using this machine for cutting from the solid, a gear having 160 teeth of approximately 3.5 circular pitch, two cuts were taken for milling each tooth space with a

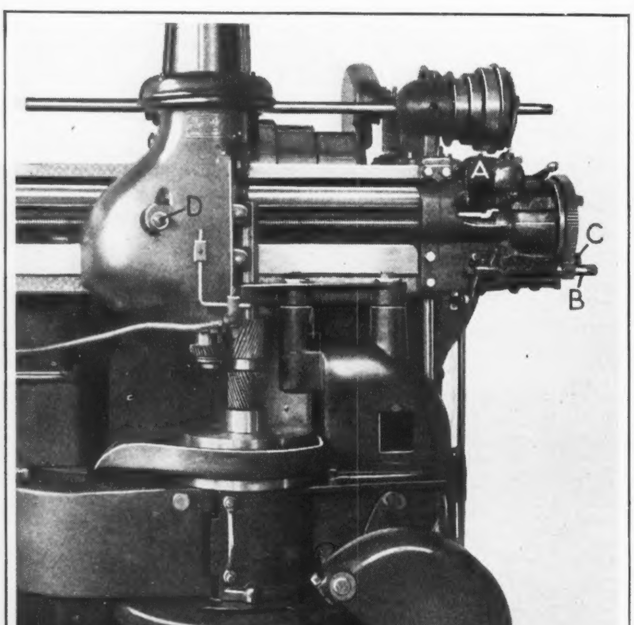


Fig. 19. Cutting a Herringbone Pinion on a Gear Shaper

feeding movement of about 1½ inches per minute. The gear was made of cast steel having a carbon content of approximately 0.40 per cent. The end-mill type of machine is especially adapted for cutting shrouded or semi-shrouded gears, since this reinforcement at the ends of the teeth would interfere with the use of either a hob or a planing tool.

While an end-mill reproduces its shape in a helical gear with a fair degree of accuracy, this is not true of an ordinary disk cutter, although the latter is more efficient for milling than an end-mill. The disk cutter, however, is seldom used for cutting helical types of gearing, except when this work is done on a small scale with an ordinary milling machine. Any type of formed cutter is inferior to cutters that are used in machines designed to generate the tooth curves. This is partly because the shapes of the tooth spaces vary for different numbers of teeth; while this is cared for automatically in a generating process, if formed cutters are used different shapes must be employed for cutting gearing varying considerably in size, as in the case of a herringbone gear and its mating pinion. Even when two formed cutters of different shapes are used, these shapes are only correct

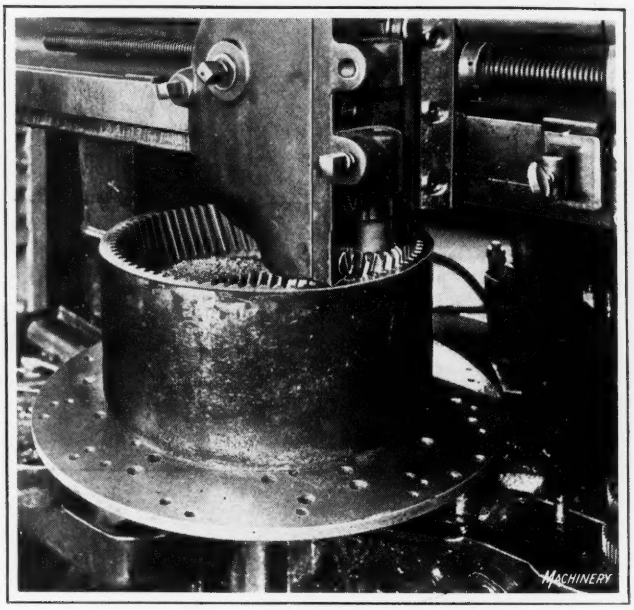


Fig. 20. Cutting an Internal Herringbone Gear

for a given number of teeth. In view of this, and because of the cost and difficulty of making formed cutters of different shapes for each pitch, the formed cutter method is not as practicable as the hobbing and planing processes.

* * *

THE BRITISH AUTOMOBILE INDUSTRY

In a speech made by Sir Herbert Austin at a recent meeting of the National Union of Manufacturers in England, Sir Herbert said he anticipated that this year Great Britain would import 50,000 American-made motor vehicles, compared with a home production of 75,000. In his opinion there were too many automobile manufacturers in Great Britain, and they would probably have to combine and economize, to reduce costs. It is evident that the British automobile manufacturers are intent upon cutting costs, and that the productive capacity of existing plants is being carefully investigated. There has been a hesitancy on the part of manufacturers to buy sufficient equipment to meet their requirements, but with a good season for the industry fairly well assured, buyers are now entering the new tool market with greater freedom.

The Institution of Automobile Engineers of Great Britain will hold its summer meeting at Liverpool, beginning June 18. During this meeting the members of the institution will visit many works devoted to industries differing from those with which they are brought into contact in their daily work.

Tap Drill Sizes of Tap and Die Institute

In connection with the standardization work of The Tap and Die Institute, the standard tap drill sizes given in the accompanying tables have been adopted. Table 1 is for machine screws, and it covers pitches conforming to the A.S.M.E. standard and special machine screws, as well as older standards. Table 2 covers screw threads of fractional sizes ranging from 1/16 inch up to 4 inches in diameter; this table also includes U. S. standard and special pitches.

The drills listed in each table are commercial sizes, and the drill diameter is selected to give approximately 75 per cent of the standard thread depth. This depth is commonly employed in manufacturing practice, and the percentage of thread depth might be further reduced without danger of making the tapped thread weak in proportion to the strength of the bolt or screw. In fact, tests have shown that a depth of 50 per cent is ample for a U. S. form of thread, so far as strength is concerned. The practical advantage of using tap drills which are somewhat larger than the root diameter of the tap is that the tapping operation requires less power and tap breakage is greatly reduced. In accordance with commercial practice, the tap drill sizes are designated by the use of numbers and letters for certain diameters not indicated by fractional dimensions.

TABLE 1. TAP DRILL SIZES FOR A. S. M. E. STANDARD AND SPECIAL MACHINE SCREW THREADS, ADOPTED BY TAP AND DIE INSTITUTE

Screw No. and Threads per Inch	Outside Diameter, Inches	Tap Drill Diameter, Inches*	Decimal Equivalent of Tap Drill Diameter	Screw No. and Threads per Inch	Outside Diameter, Inches	Tap Drill Diameter, Inches*	Decimal Equivalent of Tap Drill Diameter
0-80	0.0600	3/64	0.0469	10-24	0.1900	25	0.1495
1-56	0.0730	54	0.0550	28	0.1900	23	0.1540
64	0.0730	53	0.0595	30	0.1900	22	0.1570
72	0.0730	53	0.0595	32	0.1900	21	0.1590
2-56	0.0860	50	0.0700	12-24	0.2160	16	0.1770
64	0.0860	50	0.0700	28	0.2160	14	0.1820
3-48	0.0990	47	0.0785	32	0.2160	13	0.1850
56	0.0990	45	0.0820	14-20	0.2420	10	0.1935
4-32	0.1120	45	0.0820	24	0.2420	7	0.2010
36	0.1120	44	0.0860	16-18	0.2680	3	0.2130
40	0.1120	43	0.0890	20	0.2680	7/32	0.2187
48	0.1120	42	0.0935	22	0.2680	2	0.2210
5-36	0.1250	40	0.0980	18-18	0.2940	B	0.2380
40	0.1250	38	0.1015	20	0.2940	D	0.2460
44	0.1250	37	0.1040	20-16	0.3200	G	0.2610
6-32	0.1380	36	0.1065	18	0.3200	17/64	0.2656
36	0.1380	34	0.1110	20	0.3200	I	0.2720
40	0.1380	33	0.1130	22-16	0.3460	9/32	0.2812
7-30	0.1510	31	0.1200	18	0.3460	L	0.2900
32	0.1510	31	0.1200	24-16	0.3720	5/16	0.3125
36	0.1510	1/8	0.1250	18	0.3720	O	0.3160
8-30	0.1640	30	0.1285	26-14	0.3980	21/64	0.3281
32	0.1640	29	0.1360	16	0.3980	R	0.3390
36	0.1640	29	0.1360	28-14	0.4240	T	0.3580
40	0.1640	28	0.1405	16	0.4240	23/64	0.3594
9-24	0.1770	29	0.1360	30-14	0.4500	V	0.3770
30	0.1770	27	0.1440	16	0.4500	25/64	0.3906
32	0.1770	26	0.1470	.....	......	.....	......

Machinery

*The tap drills listed are commercial sizes, and allow for approximately 75 per cent of the standard thread depth.

TABLE 2. TAP DRILL SIZES FOR STANDARD AND SPECIAL SCREW THREADS OF UNITED STATES STANDARD FORM, ADOPTED BY THE TAP AND DIE INSTITUTE

Nominal Size and Threads per Inch	Tap Drill Diameter, Inches*	Decimal Equivalent of Tap Drill Diameter	Nominal Size and Threads per Inch	Tap Drill Diameter, Inches*	Decimal Equivalent of Tap Drill Diameter	Nominal Size and Threads per Inch	Tap Drill Diameter, Inches*	Decimal Equivalent of Tap Drill Diameter
1/16-64	3/64	0.0469	3/8-20	21/64	0.3281	7/8 -27	27/32	0.8437
72	3/64	0.0469	24	Q	0.3320	5/16- 9	53/64	0.8281
5/64-60	1/16	0.0625	27	R	0.3390	1-8	7/8	0.8750
72	52	0.0635	7/16-14	U	0.3680	12	59/64	0.9219
3/32-48	49	0.0730	20	25/64	0.3906	14	15/16	0.9375
50	49	0.0730	24	X	0.3970	27	31/32	0.9687
7/64-48	43	0.0890	27	Y	0.4040	1 1/8-7	63/64	0.9844
1/8-32	3/32	0.0937	1/2-12	27/64	0.4219	12	1 3/64	1.0469
40	38	0.1015	13	27/64	0.4219	1 1/4-7	1 7/64	1.1094
9/64-40	32	0.1160	20	29/64	0.4531	12	1 11/64	1.1719
5/32-32	1/8	0.1250	24	29/64	0.4531	1 3/8-6	1 7/32	1.2187
36	30	0.1285	27	15/32	0.4687	12	1 19/64	1.2969
11/64-32	9/64	0.1406	9/16-12	31/64	0.4844	1 1/2-6	1 11/32	1.3437
3/16-24	26	0.1470	18	33/64	0.5156	12	1 27/64	1.4219
32	22	0.1570	27	17/32	0.5312	1 5/8-5 1/2	1 29/64	1.4531
13/64-24	20	0.1610	5/8-11	17/32	0.5312	1 3/4-5	1 9/16	1.5625
7/32-24	16	0.1770	12	35/64	0.5469	1 7/8-5	1 11/16	1.6875
32	12	0.1890	18	37/64	0.5781	2-4 1/2	1 25/32	1.7812
15/64-24	10	0.1935	27	19/32	0.5937	2 1/8-4 1/2	1 29/32	1.9062
1/4-20	7	0.2010	11/16-11	19/32	0.5937	2 1/4-4 1/2	2 1/32	2.0312
24	4	0.2090	16	5/8	0.6250	2 3/8-4	2 1/8	2.1250
27	3	0.2130	3/4-10	21/32	0.6562	2 1/2-4	2 1/4	2.2500
28	3	0.2130	12	43/64	0.6719	2 3/4-4	2 1/2	2.5000
32	7/32	0.2187	16	11/16	0.6875	3-3 1/2	2 23/32	2.7187
5/16-18	F	0.2570	27	23/32	0.7187	3 1/4-3 1/2	2 31/32	2.9687
20	17/64	0.2656	13/16-10	23/32	0.7187	3 1/2-3 1/4	3 3/16	3.1875
24	I	0.2720	7/8-9	49/64	0.7656	3 3/4-3	3 7/16	3.4375
27	J	0.2770	12	51/64	0.7969	4-3	3 11/16	3.6875
32	9/32	0.2812	14	13/16	0.8125	....	....	......
3/8-16	5/16	0.3125	18	53/64	0.8281	....	....	......

Machinery

*The tap drills listed are commercial sizes, and allow for approximately 75 per cent of the standard thread depth.

TAP DRILL SIZES

By GEORGE C. HANNEMAN

The accompanying table of tap drill sizes will be of value to both the designer and the man in the shop. It gives the theoretical percentage of a full thread (from 50 to 100 per cent) obtainable when using standard sizes of drills for the holes to be tapped, the percentage to be employed being left to the judgment of the user. To illustrate the use of the table, suppose that it is desired to drill a hole that will tap out with a ½-13 tap and give about 75 per cent of a full thread. Referring to the table, it will be found, in the column under ½-13, that a 27/64-inch drill will leave enough stock for 78 per cent of a full thread, and this size of drill would therefore be used. In actual practice, the percentage of thread given in the table is not obtained exactly, as drills usually cut a little over size; on the other hand, in materials of a tough nature, particularly copper,

TAP DRILL SIZES FOR SCREWS WITH U. S. FORM OF THREAD

This Table shows the Percentage of a Full Thread Obtainable with Drills of Standard Sizes

Size of Screw

Number 0-80		Number 1-72		Number 1-64		Number 2-64		Number 2-56		Number 3-56		Number 3-48		Number 4-48		Number 4-40		Number 4-36	
Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread
57	100	54	100	55	100	51	94	1/16	100	48	99	49	96	44	96	46	96	48	100
56	83	53	75	54	89	50	79	52	97	5/64	99	48	85	43	85	45	92	5/64	94
3/64	81	1/16	58	53	67	49	64	51	82	47	90	5/64	77	42	68	44	80	47	93
55	49	52	53	1/16	52	48	49	50	69	46	77	47	76	3/32	67	43	71	46	86
								49	56	45	73	46	66	41	59	42	57	45	83
										44	56	45	63	40	52	3/32	56	44	72
												44	48			41	49	43	64
																		42	51
																		3/32	50

Number 5-44		Number 5-40		Number 5-36		Number 6-40		Number 6-36		Number 6-32		Number 7-36		Number 7-32		Number 7-30		Number 8-36	
41	98	42	97	43	100	36	97	38	100	40	99	32	97	35	100	7/64	96	30	98
40	91	3/32	96	42	87	7/64	88	37	94	39	95	31	86	34	99	35	95	29	77
39	86	41	89	3/32	86	35	86	36	87	38	90	1/8	72	33	94	34	92	28	65
38	80	40	83	41	80	34	83	7/64	79	37	84	30	62	32	86	33	88	9/64	64
37	71	39	78	40	75	33	77	35	77	36	78			31	76	32	81	27	55
36	63	38	72	39	70	32	68	34	75	7/64	71			1/8	64	31	72		
7/64	53	37	65	38	65	31	55	33	69	35	69			30	55	1/8	60		
35	51	36	57	37	58			32	61	34	66					30	52		
		7/64	48	36	51			31	50	33	61								
										32	54								

Number 8-32		Number 8-30		Number 9-32		Number 9-30		Number 9-24		Number 10-32		Number 10-30		Number 10-24		Number 12-28		Number 12-24	
1/8	100	31	100	29	100	29	95	1/8	96	24	94	26	99	29	100	11/64	95	20	100
30	87	1/8	90	28	90	28	84	30	90	23	89	25	93	28	92	17	93	19	92
29	69	30	82	9/64	89	9/64	84	29	76	5/32	83	24	88	9/64	91	16	84	18	86
28	58	29	65	27	81	27	74	28	68	22	81	23	83	27	85	15	78	11/64	82
9/64	57	28	54	26	74	26	69	9/64	67	21	76	5/32	78	26	80	14	73	17	79
27	49	9/64	54	25	68	25	63	27	61	20	71	22	76	25	75	13	67	16	72
				24	61	24	58	26	55	19	59	21	72	24	70	3/16	61	15	66
				23	57	23	53	25	51	18	51	20	67	23	67	12	58	14	63
				5/32	51	5/32	48					19	55	5/32	62	11	54	13	57
				22	49									22	61	10	51	3/16	52
														21	57			12	50
														20	54				

Number 14-24		Number 14-20		1/4-28		1/4-24		1/4-20		Number 16-22		Number 16-20		Number 18-20		Number 18-18		5/16-24	
12	98	16	100	6	99	9	100	13	100	4	100	13/64	100	1	100	2	100	G	95
11	94	15	95	5	96	8	94	3/16	96	3	93	6	98	A	92	1	91	17/64	84
10	90	14	92	4	88	7	91	12	94	7/32	83	5	96	15/64	92	A	83	H	86
9	85	13	88	3	80	13/64	86	11	91	2	80	4	91	B	83	15/64	83	I	75
8	79	3/16	84	7/32	67	6	85	10	87	1	67	3	85	C	77	B	75	J	66
7	76	12	81	2	62	5	82	9	83	A	58	7/32	76	D	71	C	69	K	58
13/64	72	11	78	1	47	4	76	8	78	15/64	57	2	72	1/4	65	D	64	9/32	58
6	70	10	75			3	68	7	75	B	51	1	61	F	54	1/4	58		
5	67	9	71			7/32	58	13/64	72			A	52	G	48	F	49		
4	61	8	66			2	54	6	71			15/64	52						
3	53	7	63					5	68										
		13/64	60					4	62										
		6	58					3	57										
		5	56					7/32	48										
		4	51																

Machinery

bronze, and soft iron, the tap raises the thread a little, thus producing a fuller thread than that indicated in the table, especially after the tap becomes slightly dull.

While the sizes of drills required to give 100 per cent full threads are given in the table (in some instances), it must not be assumed that full threads are usually cut or even that they can be cut under ordinary conditions. To cut a 100 per cent thread is a slow process which must be done by hand, and is never required except in making thread gages, scientific apparatus, and similar work.

As good general practice for machine tapping, the writer would suggest using a drill that will give about 75 per cent of a full thread. This percentage rarely needs to be exceeded, and is just about right for tapping machine steel or cold-rolled steel with good tools when sufficient lubricant is supplied, provided the tap is not one of the smallest sizes. For very small sizes, it will be found impossible to tap more than 60 per cent or possibly 65 per cent of a full thread without undue tap breakage. Very large taps do not have to cut more than 75 per cent of a full thread as a rule, because a fuller thread is not required in the larger sizes to give the necessary strength. In some cases even 60 per cent of a full thread is sufficient, and it is only a waste of time and an added expense for taps and

TAP DRILL SIZES FOR SCREWS WITH U. S. FORM OF THREAD (CONTINUED)

This Table shows the Percentage of a Full Thread Obtainable with Drills of Standard Sizes

Size of Screw																			
5/16-18		Number 20-20		Number 20-18		Number 22-18		Number 22-16		Number 24-18		Number 24-16		⅜-24		⅜-16		Number 26-16	
Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread	Number or Diameter of Tap Drill	Per Cent of Full Thread
C	98	F	97	¼	97	J	96	17/64	99	N	97	L	100	P	91	M	98	O	100
D	92	G	91	F	87	K	90	H	98	5/16	82	M	95	21/64	82	19/64	96	P	92
¼	86	17/64	83	G	82	9/32	90	I	91	O	77	19/64	93	Q	75	N	90	21/64	86
F	77	H	83	17/64	75	L	77	J	85	P	68	N	86	R	63	5/16	77	Q	81
G	71	I	74	H	75	M	71	K	80	21/64	60	5/16	73	11/32	55	O	73	R	74
17/64	63	J	66	I	66	19/64	68	9/32	80	Q	55	O	69	S	47	P	64	11/32	67
H	64	K	60	J	60	N	61	L	69	R	46	P	60			21/64	59	S	62
I	56	9/32	59	K	54	5/16	47	M	63			21/64	54			Q	53	T	49
J	49	L	46	9/32	54			19/64	60			Q	49						
Number 26-14		Number 28-16		Number 28-14		7/16-20		7/16-14		Number 30-16		Number 30-14		½-20		½-13		½-12	
5/16	92	11/32	99	Q	99	⅜	96	S	96	U	100	T	99	7/16	96	Y	96	25/64	100
O	88	S	93	R	92	V	93	T	85	⅜	92	23/64	97	29/64	72	13/32	94	X	95
P	81	T	81	11/32	86	W	79	23/64	84	V	90	U	88	15/32	48	Z	87	Y	89
21/64	75	23/64	80	S	82	25/64	72	U	75	W	79	⅜	81			27/64	78	13/32	87
Q	71	U	69	T	71	X	62	⅜	67	25/64	73	V	79			7/16	63	Z	80
R	64	⅜	60	23/64	70	Y	51	V	65	X	65	W	69			29/64	47	27/64	72
11/32	58	V	58	U	60	13/32	48	W	55	Y	57	25/64	64					7/16	58
S	54	W	47	⅜	53			25/64	50	13/32	54	X	57						
				V	51							Y	50						
9/16-20		9/16-12		⅝-18		⅝-11		11/16-16		11/16-11		¾-16		¾-10		13/16-10		⅞-20	
½	96	29/64	100	9/16	86	33/64	91	39/64	96	37/64	92	43/64	96	⅝	96	11/16	96	13/16	96
33/64	72	15/32	87	37/64	65	17/32	79	⅝	77	19/32	79	11/16	77	41/64	84	45/64	84	53/64	72
17/32	48	31/64	72			35/64	66	41/64	57	39/64	66	45/64	58	21/32	72	23/32	72	27/32	48
		½	57			9/16	53			⅝	53			43/64	60	47/64	60		
														11/16	48	¾	48		
⅞-14		⅞-9		15/16-9		1-20		1-14		1-8		1 1/16-8		1⅛-12		1⅛-7		1 3/16-7	
25/32	100	47/64	97	51/64	97	15/16	96	29/32	100	27/32	96	29/32	96	1 1/64	100	61/64	92	1 1/64	92
51/64	84	¾	86	13/16	86	61/64	72	59/64	84	55/64	86	59/64	86	1 1/32	86	31/32	84	1 1/32	84
13/16	67	49/64	76	53/64	76	31/32	48	15/16	67	⅞	77	15/16	77	1 3/64	72	63/64	76	1 3/64	76
53/64	50	25/32	65	27/32	65			61/64	50	57/64	67	61/64	67	1 1/16	58	1	67	1 1/16	67
		51/64	54	55/64	54					29/32	57	31/32	58			1 1/64	59	1 5/64	59
				⅞	43					59/64	48	63/64	48			1 1/32	50	1 3/32	51
1¼-12		1¼-7		1 5/16-7		1⅜-12		1⅜-6		1½-6		1⅝-5½		1¾-5		1⅞-5		2-4½	
1 9/64	100	1 1/16	100	1⅛	100	1 17/64	100	1 5/32	100	1 9/32	100	1 25/64	99	1½	96	1⅝	96	1 23/32	97
1 5/32	86	1 5/64	92	1 9/64	92	1 9/32	86	1 11/64	94	1 19/64	94	1 13/32	93	1 33/64	90	1 41/64	90	1 47/64	92
1 11/64	72	1 3/32	84	1 5/32	84	1 19/64	72	1 3/16	87	1 5/16	87	1 27/64	86	1 17/32	84	1 21/32	84	1¾	87
1 3/16	58	1 7/64	76	1 11/64	76	1 5/16	58	1 13/64	79	1 21/64	79	1 7/16	79	1 35/64	78	1 43/64	78	1 49/64	81
		1⅛	67	1 3/16	67			1 7/32	72	1 11/32	72	1 29/64	72	1 9/16	72	1 11/16	72	1 25/32	76
		1 9/64	59	[illegible]	59			1 15/64	65	1 23/64	65	1 15/32	66	1 37/64	66	1 45/64	66	1 51/64	70
		1 5/32	51	1 7/32	51			1¼	58	1⅜	58	1 31/64	59	1 19/32	60	1 23/32	60	1 13/16	65
								1 17/64	51	1 25/64	51	1½	53	1 39/64	54	1 47/64	54	1 53/64	59
														1⅝	48	1¾	48	1 27/32	54
																		1 55/64	49

Machinery

power to attempt to tap a fuller thread. Only in the case of cast iron, and occasionally brass, would more than 75 per cent of a full thread be required, and even with these metals it is not advisable to attempt to obtain too full a thread, as this will result in tearing off the top of the thread so that nothing will be gained.

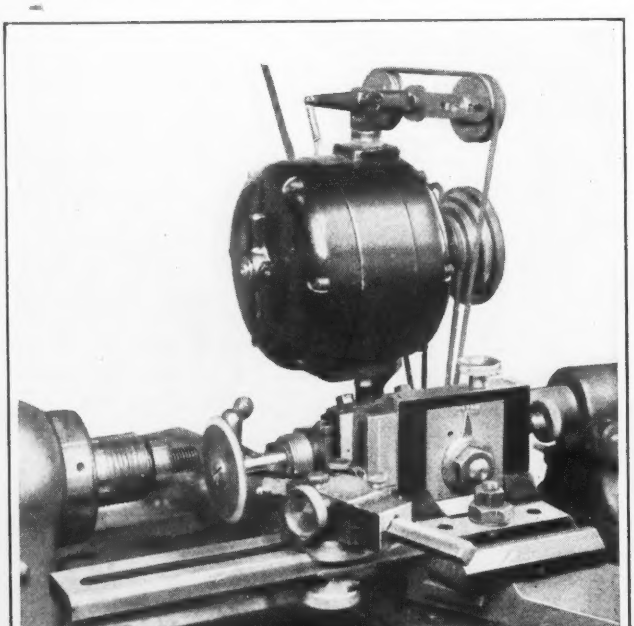
On big production work, manufacturing costs can often be cut down considerably by experimenting with the machine tapping operations until it is determined just how small a percentage of a full thread can be depended upon to meet requirements. Usually this will be found to be less than 75 per cent of a full thread. In some cases it has been possible to cut down tap breakage nearly 90 per cent by using a tap drill only one size larger than the one originally selected. Further information on tap drill sizes is given on page 866 of MACHINERY'S HANDBOOK.

* * *

GRINDING THREADS ON HARD RUBBER

Parts made of hard rubber have previously been threaded by the methods ordinarily employed for metals, a single-pointed threading tool or a self-opening die-head being used; but the nature of hard rubber is such that the cutting tool leaves a very ragged thread. In addition, the action of the rubber on chasers or threading tools is like that of an abrasive, so that tools require frequent sharpening.

Samples of hard rubber rods, to be used in making electrical plugs, were recently sent to the Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., and it was found that threads of good quality could be formed readily by grinding. As illustrated, the grinding wheel is mounted on a multi-graduated precision grinder, held on a lathe carriage. The piece of hard rubber to be threaded is held in the draw-in collet of a Porter-Cable tool-room lathe. With this equipment a well-formed thread was produced at one passage of the wheel; in other words, the time required to form a complete thread by grinding is equivalent to the time required for the carriage to travel the length of the thread, which is approximately 1¼ inches. The grinding wheel, dressed to a 60-degree angle, retains its sharp edge indefinitely, if the wheel selected is adapted to this operation. The multi-tooth effect of the wheel imparts a fine finish to the thread.



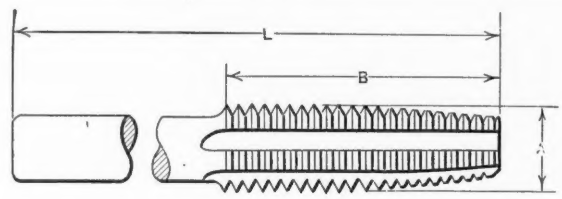
Grinding Threads on Hard Rubber, using a Multi-Graduated Precision Grinder

DIMENSIONS FOR TAPPER TAPS

The standard dimensions for tapper taps recently adopted by the Tap & Die Institute are given in the accompanying table.

C. M. P.

DIMENSIONS FOR TAPPER TAPS



L = 12 or 15 inches for all sizes up to and including 1 inch in diameter; for all larger sizes L = 15 inches.

Diameter A of Tap, Inches	Number of Threads per Inch			Length B of Thread, Inches	
	U. S. Standard	S. A. E. Standard	Whitworth Standard	U. S. and Whitworth Standards	S. A. E. Standard
¼	20	28	20	1⅝	1¼
5/16	18	24	18	1 13/16	1⅜
⅜	16	24	16	2	1½
7/16	14	20	14	2¼	1 11/16
½	13	20	12	2¼	1 11/16
9/16	12	18	12	2½	1⅞
⅝	11	18	11	2½	1⅞
11/16	11	16	11	2½	1⅞
¾	10	16	10	2¾	2
13/16	10	....	10	2¾	....
⅞	9	14*	9	3	2
15/16	9	....	9	3	....
1	8	14	8	3½	2⅝
1⅛	7	12	7	3½	2⅝
1¼	7	12	7	3½	2⅝
1⅜	6	12	6	4	3
1½	6	12	6	4	3
1⅝	5½	....	5	4	....
1¾	5	....	5	4½	....
1⅞	5	....	4½	4½	....
2	4½	....	4½	4½	....

Machinery

*Also made by members of The Tap & Die Institute with 18 threads per inch.

* * *

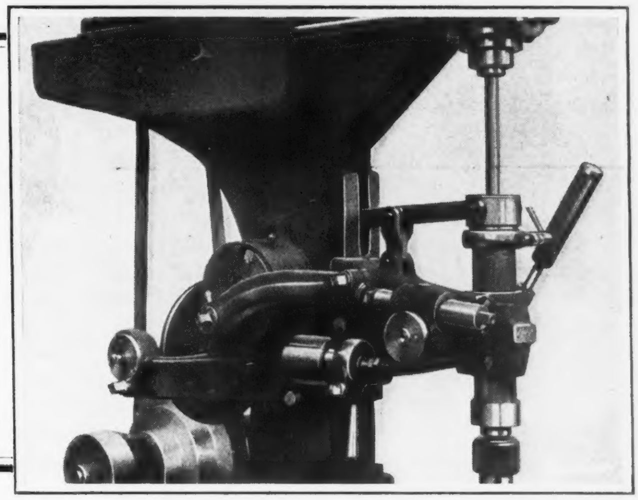
THE VALUE OF A GOOD REPAIR SHOP

By CHARLES W. LEE

Why is it that every cent put into the repair shop of an industrial plant is considered a dead expense, while the cost of equipment used in the manufacturing departments seems to be considered a proper investment? It appears to the writer that it is just as desirable to be able to perform repairs economically as it is to manufacture economically, and if this is true, adequate equipment in the repair shop is just as necessary as in the manufacturing plant. This alone is a real argument for a good repair shop as an investment, but the following experience will bring out the point more forcibly.

Recently a new works manager was engaged by the directors of a large manufacturing plant. He found the repair shop to be the weakest spot, and the first thing he asked for in the way of additional equipment was machinery worth $30,000 for the repair shop. His proposal was considered unreasonable, but he kept on fighting for his repair shop equipment until he got it. At the end of the first year, more than $30,000 worth of additional products had been made in the factory without additional plant equipment or operators, simply because when a machine broke down in the factory it could be repaired promptly, instead of having to stand idle, waiting for the repairs to be done, as had formerly been the case.

Automatic Feeding Device for High-speed Drilling



By CHARLES E. BERNITT

THE manufacturers of small cast-iron, brass, or aluminum parts are continually demonstrating the advantage of using extremely high speeds for drilling small holes. A number of manufacturers have recently brought out sensitive drilling machines provided with ball bearings that are capable of sustaining spindle speeds as high as 12,000 and 15,000 revolutions per minute to meet the demand for this kind of work. Obviously, such high spindle speeds demand an exceedingly rapid feeding movement. For example, if it is required to drill a 1/16-inch hole in soft brass, and the drill point is correctly ground and all conditions are favorable, it might be found that the most efficient cutting speed is around 200 feet per minute. This requires a drilling speed of about 12,000 revolutions per minute, and assuming that the feed is 0.0025 inch per revolution, the rate of penetration should be approximately 30 inches per minute, or ½ inch per second. Thus it is evident that the operation of drilling small holes often appears more like punching than drilling. This is especially true of through holes in thin material.

Many types of feeding arrangements are used for this work, including the regular hand-feed lever which is undoubtedly the best means of feeding except for the fact that it prevents the operator from using both hands in loading and unloading the fixture or otherwise handling the work. The foot-treadle feed is used to some extent, but it is rapidly losing favor due to its lack of sensitiveness and the attendant breaking of drills.

To overcome these objections, several types of gravity feed and friction feed mechanisms have been brought out by different makers of sensitive drilling machines, which have resulted in an increase in production. An automatic feed of the friction type is shown in the heading illustration attached to a high-speed sensitive drilling machine built by the Avey Drilling Machine Co., of Cincinnati, Ohio. While this device might be classed as a positive feed type, to distinguish it from the weight or gravity feed types, it is nevertheless operated by a friction disk and pinion, which permit slippage when the drill is subjected to undue torsional stresses. The pressure of the leather-faced driving pinion on the disk may be adjusted to suit the size of drill being used.

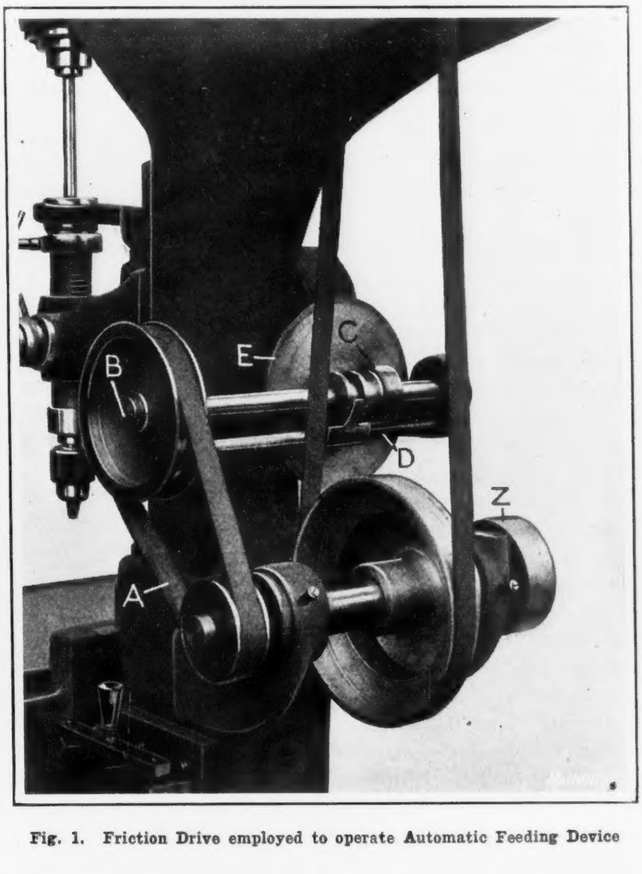


Fig. 1. Friction Drive employed to operate Automatic Feeding Device

A means of instantly varying the number of strokes per minute, and provision for changing the depth of stroke and rate of feed are other desirable features incorporated in this feeding device. The position of the spindle in relation to the work, when in the upward position, can be changed without moving the head on the drilling machine column. Front and rear views of the device are shown in the heading illustration and Fig. 1, respectively.

The rear shaft *B*, Fig. 1, is driven by means of a belt *A* from a pulley mounted on the end of the machine countershaft. On shaft *B* is mounted the leather-faced pinion *C* which engages the friction disk *E*. The position of pinion *C* can be adjusted by means of screw *D* to change the number of strokes per minute. The countershaft is driven by a motor mounted on the drilling machine column, which is connected by belt to pulley *Z*.

In Fig. 2 is shown an assembly view of the feeding mechanism, exclusive of the machine countershaft and the spindle, drill, and chuck. The friction disk *E* is mounted on the end of shaft *F*, which is designed to allow an endwise adjustment through the worm *G* and bushing *H*. The key in bushing *H* transmits motion from shaft *F* to worm *G*, and thence to worm-wheel *Y*. The worm-wheel is mounted on a double-row ball bearing, as shown in the sectional view. On the outer face or flange of the worm-wheel shaft is a T-slot which carries crank block *I*. In order to change the depth or length of the drill stroke, block *I* is adjusted to and from the center of the worm-wheel by means of screw *J*, and is clamped in the desired position by stud *K*.

On stud *K* is a bushing *L*, which has a bearing in crank-arm *M*. The rack bushing *N* has a sliding bearing in the oscillating yoke *O*, and engages pinion *P*, mounted on the end of the rack pinion, which imparts an up and down motion to the spindle

quill. Rod *Q* is threaded in the end of crank-arm *M*, the latter having a split clamp as shown, so that when screw *R* is loosened, rod *Q* can be turned in order to decrease or increase the effective length of the crank arm, as desired. This adjustment also changes the position of the drill spindle in relation to the work.

The bushing *S* in the worm-box has a coarse thread on its outer surface. Attached to this bushing is a lever *T* which, when turned down, draws bushing *S* outward and thus moves shaft *F* and disk *E* away from the friction pinion *C*, so that the feeding motion will be stopped without disconnecting the drive to the spindle. When lever *T* is in the upward position, the disk is held against the friction pinion by the pressure of spring *U*. This pressure can be varied to suit different sizes of drills by loosening the clamping nut *V* on lever *T* and screwing bushing *S* in or out. After the adjustment is made, lever *T* is set and clamped in the required position.

feed, and then decreasing to zero at the bottom of the stroke. This is, of course, characteristic of all crank motions, and the advantage of such a feature in drilling thin work is apparent. The drill enters the work and penetrates the scale at a comparatively fine feed, and when under the scale the feed increases rapidly to maximum and then slows up as the drill breaks through.

The choice of the proper rate of feed for any given material is a matter of actual test, and the wide range of feeds available with this device is of great advantage. In changing the position of the friction pinion to increase or decrease the number of strokes per minute, the maximum feed, in inches per revolution, is increased or decreased proportionately. For example, assuming that the devise is adjusted for fifteen strokes per minute and a 2-inch stroke, the maximum feed would be twice that obtained if the device were set for a 1-inch stroke and 15 strokes per minute. With a stroke of 1 inch and 15 strokes per minute, the maximum feed would

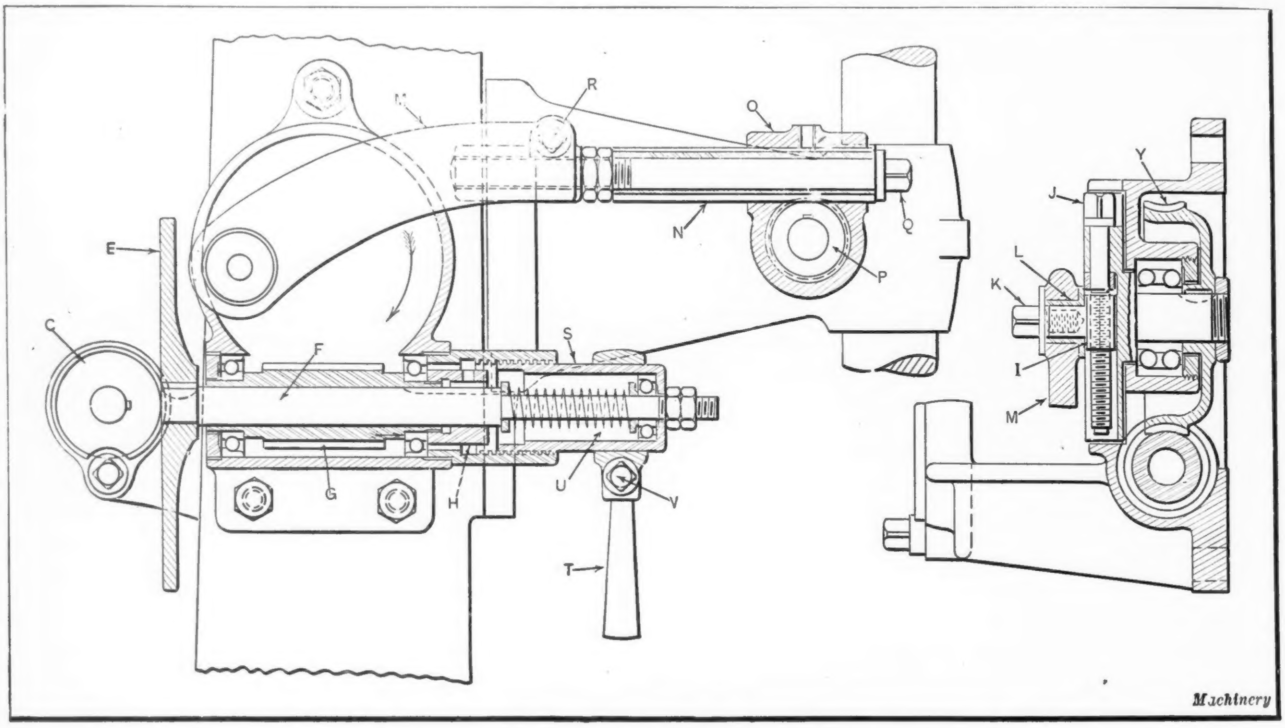


Fig. 2. Sectional View of Automatic Feeding Device for High-speed Drilling

This type of feeding device is adapted to numerous classes of work, the most common of which is the drilling of one or more holes through a plate or flat piece, which can be shifted from one hole to the other on each returning stroke of the spindle. Some parts do not require extreme accuracy in the location of the holes, and for such work greater speed can be attained by employing a fixture clamped in place under the spindle, so that the operator simply inserts a piece in the fixture and holds it there while the drill is being automatically fed downward. During the return stroke, the drilled piece is replaced by a new piece, and the operation repeated. When accuracy is essential, the feeding device is set to give a lower number of feeding strokes per minute and thus allow the operator time in which to clamp and unclamp the piece in the fixture.

The most efficient device for holding work for the rapid production of small parts is a revolving disk mounted on the table of the machine and designed to hold several fixtures properly spaced on the outer rim of the disk. With such an arrangement, provision is made for indexing the disk from one fixture to the next on the return stroke of the spindle. This permits the operator to load and unload one fixture while a piece is being drilled in the fixture directly under the spindle.

The feeding motion, with this device, is not uniform, the drill starting at zero and increasing rapidly to a maximum

be one-half that obtained with a 1-inch stroke and 30 strokes per minute. As any part of the stroke can be utilized for actual drilling, it is evident that almost any feed can be readily obtained.

* * *

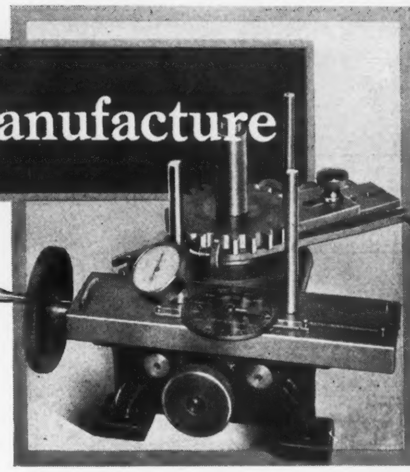
CATALOGUES WANTED BY ENGLISH LIBRARY

The public library of Coventry, England, of which Charles Nowell is the librarian, is endeavoring to bring together a representative collection of catalogues in the engineering industry, and is asking manufacturers to send their catalogues to this library for its files. The catalogues are arranged in a carefully classified order in the commercial and technical library branch, and form a useful adjunct to the books and periodicals filed in the library.

* * *

One of the problems under investigation by the Bureau of Mines is the contraction and shrinkage of metals and alloys in casting. These data are of especial interest to foundrymen and others in the metal and alloy industry. Results of measurements on the linear contraction of a series of light aluminum alloys have been published as Technical Paper No. 287 of the bureau, and an investigation is now under way on the contraction of a series of commercial brasses and bronzes. The report may be obtained from the Bureau of Mines, Washington, D. C.

Quality Control in Gear Manufacture



Equipment Employed for Inspecting the Hob, Hobbing Machine, and Finished Gear

By S. O. BJORNBERG
Consulting Engineer, Illinois Tool Works, Chicago, Ill.

THE process of manufacturing gears has reached such a state of perfection that efficiencies as high as 98 per cent have been reached by the use of gears in power transmission. There are several methods employed in making gears, but when it is a question of quantity and quality production combined, the hobbing process is very generally used. The finer the quality desired of the gears, the more accurate must be the hob that produces them, and so we find that the ground hob is rapidly coming to the front. This statement, however, must not be taken to mean that a ground hob invariably produces good gears, because there are at least two other factors that influence the quality, one of these being the hobbing machine, and the other the hobbing machine operator.

As the quality of the finished gear is necessarily a product of the hob, machine, and operator, it is desirable to keep variations due to each of these three factors within predetermined limits. For this purpose, the Illinois Tool Works have developed a number of instruments and formulated a set of rules, the combination being called "quality control." This article will briefly describe the various instruments, and explain their use in checking the accuracy of the hob, inspecting the condition of the hobbing machine, and testing the finished gear.

Requirements of a Good Hob

A hob may be likened to a hardened steel screw with a predetermined profile of the thread, portions of which have been cut away to form a series of teeth with cutting edges. In order to produce good gears, a hob must meet the following requirements:

1. The profile of the hob teeth must be uniform and conform within close limits to the theoretical outline, a rack tooth, which is properly modified, usually forming the basis of the hob tooth profile.
2. The cutting edges on the flanks of the teeth must lie in the path of a true helix which bears a definite ratio to the pitch of the gear teeth to be cut.
3. The cutting edges at the top of the teeth and bottom of the tooth spaces must be concentric with the axis of the hob.

Two machines or instruments have been developed for shop use in checking the finished hob for these requirements, these being, respectively, the contour or profile testing machine, and the lead and concentricity testing machine, described in the following.

The Contour Testing Machine

The contour testing machine, shown in Fig. 1, consists essentially of a base *A*, a hob support *B*, and a slide *C*. The hob support is made to conform to the pressure angle of the hob tooth, which is usually either 14½ or 20 degrees. Slide *C* carries an indicator operated by a lever which is so arranged that a movement of the indicator pointer through one dial division represents a movement of 0.0002 inch of the knife-edge of the lever. To record the results shown by this machine, use is made of the chart shown in Fig. 2. The vertical center line on this chart represents the tooth profile, and the curves at each end, the corrections made on the hob teeth for approach and interference. Curve *A* represents the maximum limit, curve *B*, the minimum limit, and points *C*, *D*, *E*, *F*, *G*, and *H* the maximum depth at which the hob cuts for 12, 16, 21, 23, 28, and 32 teeth, respectively. The straight portion of the tooth may vary 0.0002 inch, while the deviation of the pressure line may be plus or minus 0.0005 inch. The dimensions in ten-thousandths of an inch indicate the distances of curves *A* and *B* from the vertical center line at the various intersections.

In checking, the hob is so mounted on support *B*, Fig. 1, that the knife-edge of the lever is in line with the cutting edge of a hob tooth. Then, with the micrometer for operating slide *C* set at zero, the knife-edge of the lever is moved up to the hob tooth by means of the auxiliary screw on the slide. When contact between the hob tooth and the knife-edge has been established, as illustrated, the auxiliary screw is locked and the slide then advanced in steps of 0.010 inch by the micrometer screw. The indicator reading for each of these steps is recorded on the chart. Hobs whose profile exceeds the tolerances established are, of course, rejected, and must be reground until they come within the required specifications.

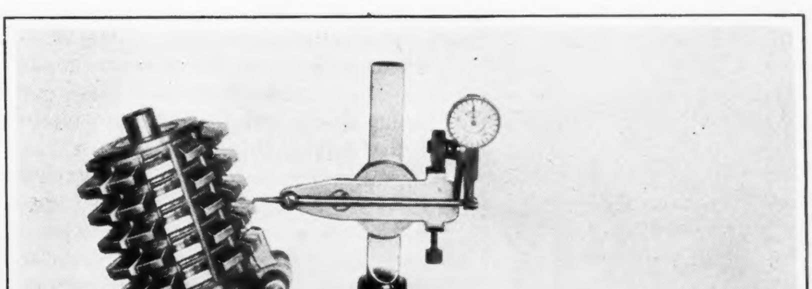


Fig. 1. Machine developed for testing the Profile of Hob Teeth

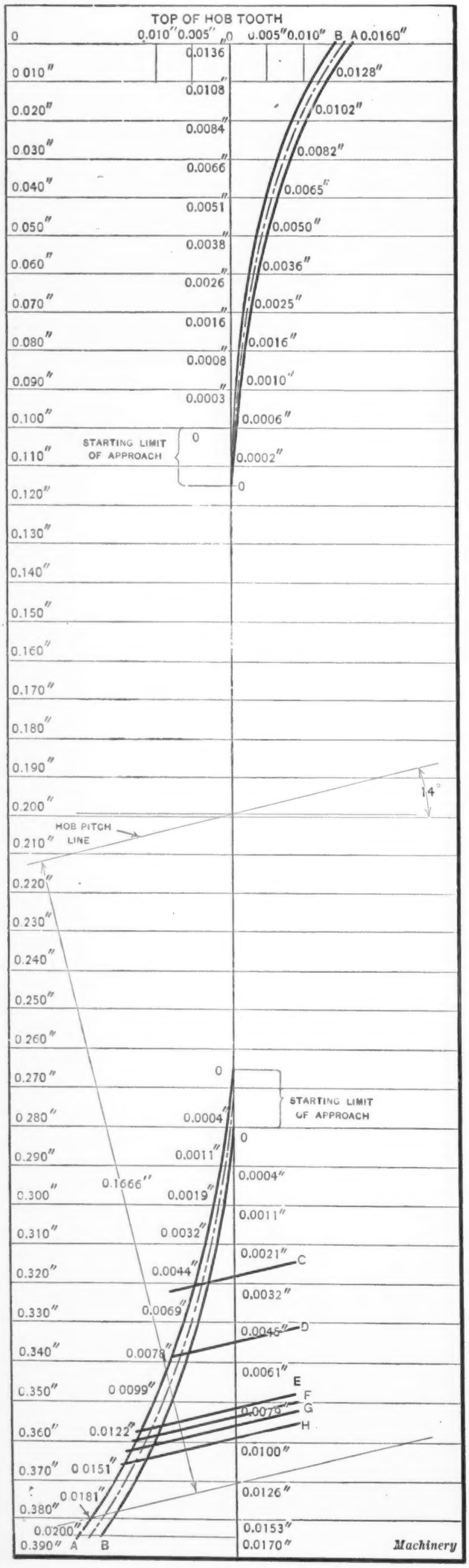


Fig. 2. Chart on which the Results obtained by the Use of the Machine in Fig. 1 are recorded

Determining the Lead and Concentricity

The hob is next checked for correctness of lead on the lead and concentricity testing machine shown in Fig. 3. This machine has four bearings cast integral with the base *A*, for supporting the main shaft *B*, which carries wheel *C*, and an auxiliary shaft on which pinion *D* and handwheel *E* are mounted. An indicator bracket is located at *F*. One end of shaft *B* is a master screw, while the other end is machined to receive the hob. To check the lead of the hob, the indicator point is brought in contact with the cutting edge on either flank of a tooth. Then the indicator point is adjusted to zero, and the hob is advanced by turning handwheel *E* until the indicator point comes in contact with the cutting edge of the next tooth. This is continued until all the teeth have passed the indicator point, after which the process is repeated for the cutting edges on the other flank of the teeth.

The readings of the indicator are plotted on the chart shown in Fig. 4, the figures at the top of the chart representing ten-thousandths of an inch. A graph obtained by drawing a line through the points plotted shows how much the cutting edges of the hob teeth deviate from the true helical path. Ground hobs of 6 to 10 diametral pitch, showing a variation in lead of not over 0.0002 inch from tooth to tooth, have been produced with the "weave" per revolution less than 0.0005 inch.

After the lead test is completed, the indicator is shifted so that it bears on the top of the teeth, to test the concentricity of the cutting edges at the top of the teeth and at the bottom of the tooth spaces. As before, the hob is rotated till every tooth has passed under the indicator point, and the readings are recorded. Commercially ground hobs should not show a variation of more than 0.001 inch in this test.

Testing Resharpened Hobs

A hob that has satisfactorily passed the three tests outlined, when properly mounted on a good machine, will produce gears of the desired accuracy. However, like all cutting tools, it will need sharpening in time, and as it is easy to spoil the accuracy of a hob in sharpening, it may be well to note a few points that should help to avoid trouble from this source. Fig. 5 shows the common way of sharpening the hob, that is, by indexing from the back of the teeth and grinding with the cone side of the wheel. As most hobs are ground with the tooth faces radial and as the wear of the wheel may cause a variation in the height of the teeth, it is advisable to check the hob for concentricity and radial cutting edges after each resharpening. This is done with the fixture shown in Fig. 6, which is provided on the right-hand side with an indicator for checking the radial height of the hob teeth. On the left-hand side there is a small support which has fingers that enter the gashes of the hob and indicate whether or not the tooth faces are radial.

Inspecting the Condition of the Hobbing Machine

A good hob, even when properly taken care of, will not produce good gears unless the hobbing machine on which it is used is in good repair and certain rules are observed in operating the machine. One of the first tests, and perhaps the most important one, that the machine should be subjected to is the velocity ratio test for determining whether the hob and work-arbors rotate with uniform velocity for a given gear ratio. The equipment for making this test was fully described in the article "Testing Gear-hobbing Machines," in December MACHINERY.

After a hobbing machine is found to have a uniform arbor velocity, it is necessary to observe a few rules in operating the machine in order to obtain good results. For instance, all chips or other foreign matter must be removed from the hob arbor, spacing collars and clamping nut before the hob is mounted, as any material caught between the shoulder or the collars would cause the arbor to spring and the hob to run out of true. It also has been found that the threads on the hob arbor or in the clamping nut are not always square with their axis and thus cause springing of the arbor. It is a good policy therefore to place an indicator on the hub of the hob after it has been mounted on the machine, and test it for "run out," so as to make sure that no trouble will arise from this source.

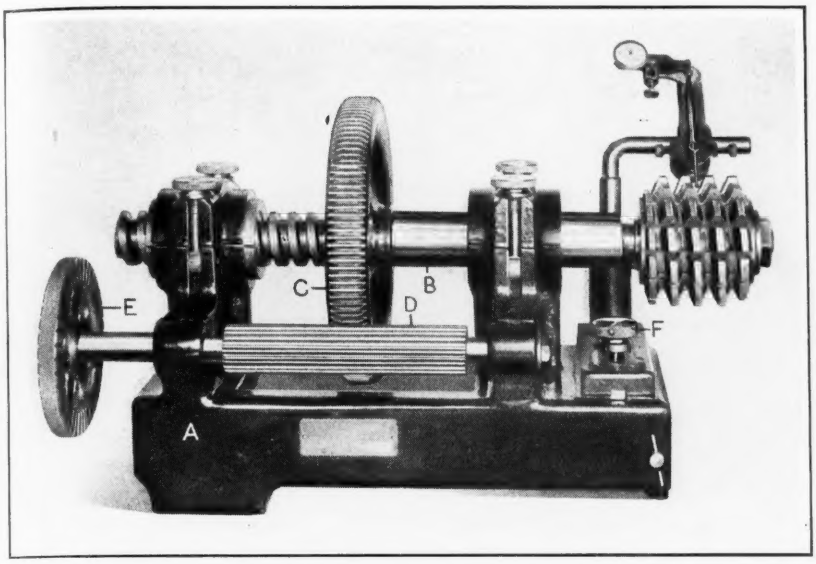


Fig. 3. Machine for testing the Correctness of Lead and the Concentricity of Cutting Edges

End play of the hob arbor and looseness of the outboard bearing are also possible sources of trouble, and must be looked out for, and corrected when they are found to exist.

The next item to consider is the condition and mounting of the change-gears. Tightly meshing gears may set up vibrations in the machine, while gears poorly machined or not meshing deep enough will invariably produce poor teeth on the gear blank being cut. Again, a work-arbor running out of true, or gear blanks with too large holes or so mounted as to cause the work-arbor to spring, are all factors to be avoided or corrected.

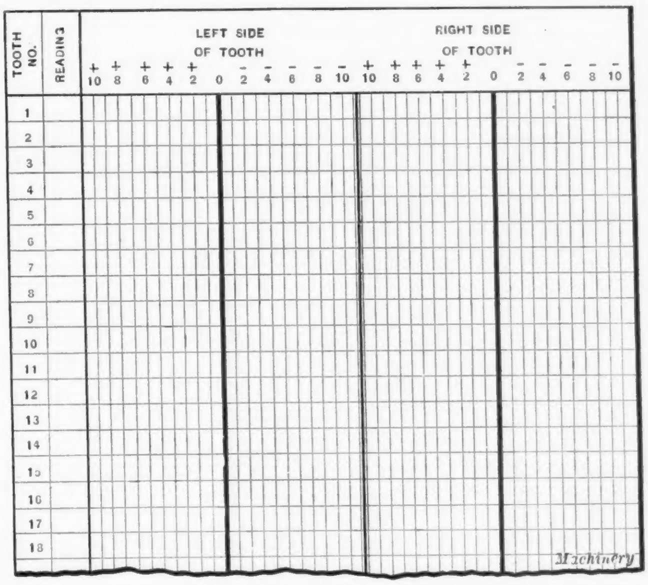


Fig. 4. Chart for recording the Results of the Lead Test

Testing a Gear Produced with the Hob

Until recently it was customary to test a finished gear in a fixture called a "vernier machine." In this fixture, a master gear is located on a stationary stud and the gear to be tested is put on a stud mounted on a slide. As a spring actuates this slide, an indicator bearing against it will show the amount of eccentricity of the teeth, as well as the "jump" between them, when the gears are rotated. If the slide is locked in a position corresponding to the center distance at which the gears are to run, the diameter and backlash can also be checked.

However, the tests made on this simple fixture give no information as to the correctness of the tooth profiles or the spacing of the teeth. In order to check these two important factors, additional instruments have been provided. One is the involute-curve testing machine shown in Fig. 7. Instruments of this type are practically all based on the fact that the end of a taut string being unwrapped from a cylinder will generate an involute curve. However, in this case, the string assumes the shape of the straight edge *aa* of slide *A*, as it is theoretically rolled from the base circle cylinder *B*. One end of the string is represented by the end of lever *C* which contacts with the tooth profile. The other end of the lever transmits motion to the dial indicator *D*. In order to check a tooth profile at a certain number of points approximately equal distances apart, the right-hand end of the gear sector *E* is made to remain in contact with the periphery of the base-circle cylinder *B*. This causes a movement of the gear sector when cylinder *B* is revolved, the movement of the sector being transmitted through a pinion to the pointer on dial *F*, which is suitably calibrated.

To use the instrument, a disk *B* corresponding in diameter to the base circle of the gear to be tested is mounted on the hub of lever *G* and locked with a nut. The gear itself is put on sleeve *H*, and held in position by pin *I* of slide *J*, the slide being clamped to lever *G* by means of a binding screw. Slide *K*, carrying the base-circle disk, gear, etc. is now moved toward slide *A* by turning the threaded knob *L* until the base-circle disk is pressed firmly against face *aa* of slide *A* under the influence of the coil spring beneath the knob. Slide *A* and the gear are next so adjusted by means of the handwheel at the left-hand end of this slide and a clamp on slide *K* that the tooth contact point of lever *C* barely touches the extreme outer part of the tooth profile.

If now the dial of indicator *D* is set at zero and a reading is taken on dial *E*, starting points are obtained for checking the involute curve. In moving slide *A* to the right in increments as indicated on dial *F*, the hand of indicator *D* should remain stationary while the tooth contact point of lever *C* travels almost to the full depth of the tooth, except at the very beginning and end of the travel, where the corrections for approach and fillets cause a slight movement of the dial hand. Should it be desired to check the other side of the tooth, indicator *D* may be mounted on the second post provided for this purpose, or the gear may be turned over. Having found the tooth contour to be correct, it is insured that there will be uniform angular velocity of the gears during the contact of any two teeth. But to maintain this angular

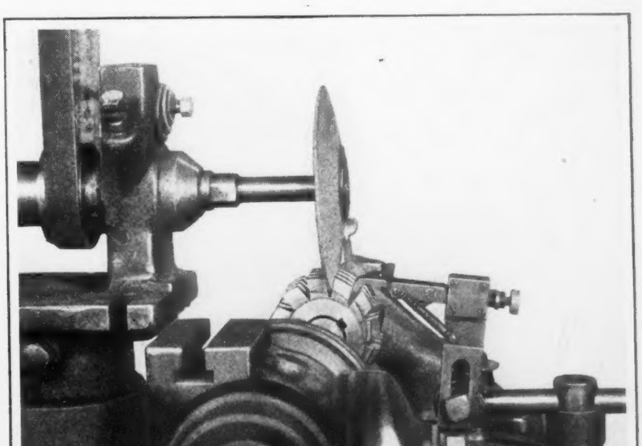


Fig. 5. Set-up commonly employed for resharpening Hob Teeth

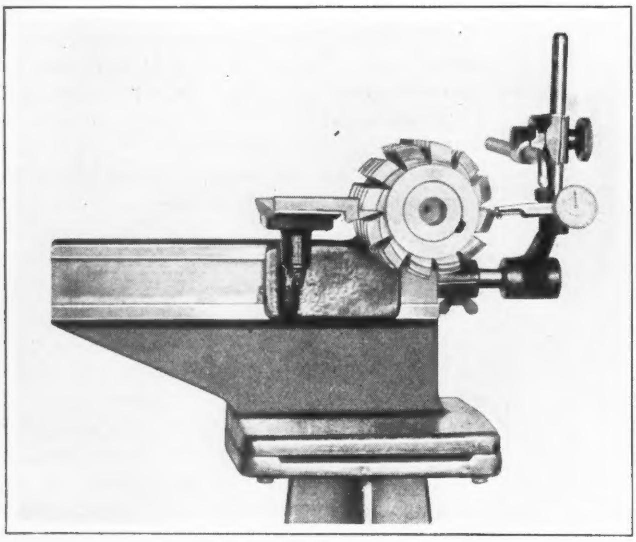


Fig. 6. Checking the Radial Height and the Face of Teeth on Resharpened Hobs

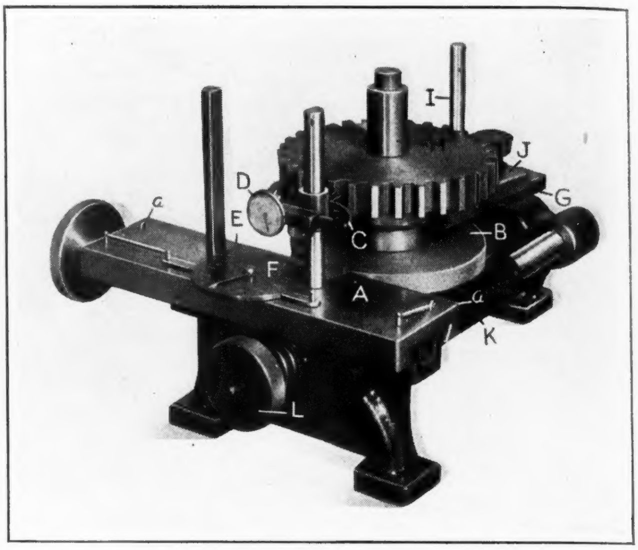


Fig. 7. Involute Curve Testing Machine used for inspecting a Finished Gear

velocity during a complete revolution, it is essential that the spacing of the teeth be correct also. This is tested by a device described in the article "Inspection of Spur Gears," which was published in February, 1922, MACHINERY.

After the gears have passed the tooth-spacing test, they are often subjected to one more test before being pronounced satisfactory. This final test is the so-called "run-in" test which determines the bearing of the teeth. The ideal bearing for spur gear teeth is one that is uniform over the greater portion of the working surface of the tooth, fading out at the base line and just at the top part of the profile. The "run-in" test consists of mounting two gears on arbors which are located so that the gears mesh properly, revolving one arbor by power and retarding the other by some such device as a Prony brake. In this manner, the tooth surfaces are caused to roll and slide over each other under pressure, and, in a brief space of time, they become brightened sufficiently to show whether or not the bearing is as it should be.

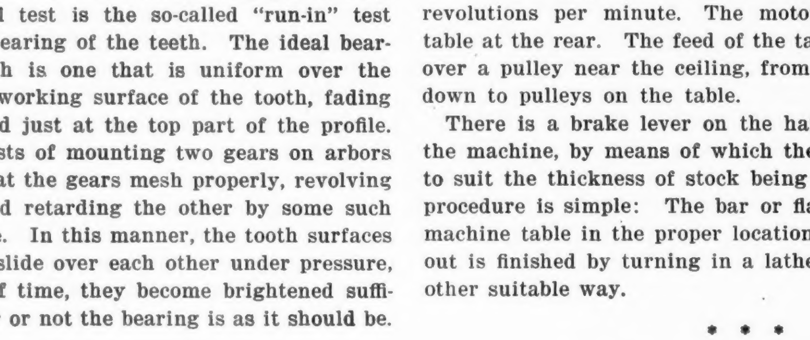
* * *

MAKING STEEL PARTS ECONOMICALLY

During the last few years there have been times when it was difficult for the manufacturer to buy forgings in small quantities. This suggested to the engineers of Sleeper & Hartley, Inc., Worcester, Mass., the possibility of cutting out blanks from rectangular stock and turning these blanks to the required shape. The adoption of this method led eventually to the design and construction of a special band saw. It is stated that by employing this means of manufacture, steel parts can be produced at a cost of three or four cents per pound.

The slitting band saw, which is here illustrated, is of a simple design, but has been found so serviceable that it is believed machines of this type would be of value to other manufacturers. The machine is similar to standard makes of band saws in so far as the drive for the saw is concerned; in fact, the design of a standard make band saw pulley arrangement has been embodied in the construction and used in connection with a feeding table. The machine is driven by a one-horsepower motor running under no load at 1200 revolutions per minute. The motor is located under the table at the rear. The feed of the table is by a weight hung over a pulley near the ceiling, from which the cable passes down to pulleys on the table.

There is a brake lever on the handwheel at the front of the machine, by means of which the feed may be regulated to suit the thickness of stock being sawed. The method of procedure is simple: The bar or flat stock is bolted to the machine table in the proper location, and after being sawed out is finished by turning in a lathe, or by finishing in any other suitable way.



Band Saw with Feeding Table for slitting as well as cutting off

* * *

VALUE OF SUPERHEATERS

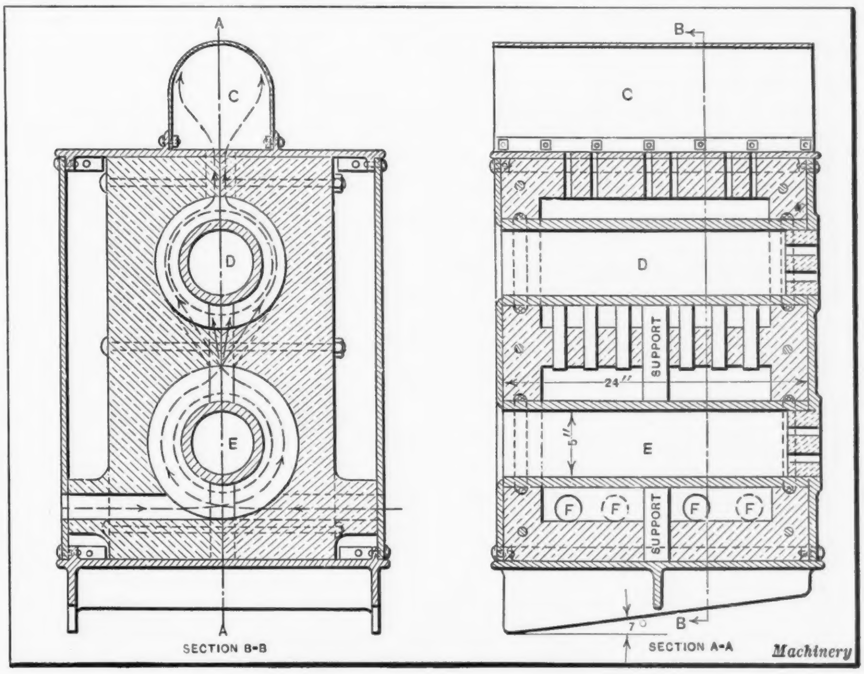
The real value of superheaters on locomotives is questioned by William H. Wood, a mechanical engineer of Media, Pa., who states that while fuel savings of some 10 per cent are effected through the use of superheaters, it costs 35 per cent of the cost of the fuel to keep the engines in repair. He claims that one of the reasons that there are so many locomotives constantly out of repair on the railroads is that the maintenance service has greatly increased since the adoption of superheaters on locomotives. Whether or not the experiences of the railroads agree with Mr. Wood's statements is not on record, but the subject is one that should be easy to investigate and the facts can doubtless be ascertained by railroad executives without a great deal of trouble.

Difficulties in Hardening High-speed Steel

By O. G. SIMMONS

THE impossibility of hardening some high-speed steels under normal conditions, even though heated and quenched according to the instructions of the manufacturers, was an unlooked for result of experiments recently conducted by the writer. The muffle furnace shown by the cross-sectional views in the accompanying illustration was employed for these experiments. This furnace has a low-temperature chamber *C*, an intermediate-temperature chamber *D*, and a high-temperature chamber *E*. The design is such that when chamber *E* has been heated to 2300 degrees F., the temperature of chamber *D* will be about 1750 degrees F., and that of chamber *C* approximately 600 degrees F. City gas was used for fuel, and was mixed with air before delivery to the four burners *F*, two of which are placed on each side of the furnace.

The intermediate- and high-temperature chambers each consist of an air-tight tube made from refractory material. The plug at the rear end of these chambers has holes to support the protecting tube of a platinum thermo-couple and a refractory pipe having a valve for controlling the volume of gas discharged into the chamber to obtain any desired atmospheric condition. It will be seen that the base of the furnace is constructed at an angle of 7 degrees with the center line of the chambers, and consequently by mounting the furnace on a horizontal base, the chambers are inclined 7 degrees. This, of course, raises the front end of the chambers slightly above the rear end, and so when gases are introduced at the rear, they are carried to the front end for discharging.



Muffle Furnace of Special Design which was used to determine the Hardening Qualities of Different High-speed Steels

The high- and intermediate-temperature chambers are supported in refractory tile, which is sealed with lime, the whole being contained within steel side walls, a cast-iron base, and a cast-iron top. The insulating effect of the lime prevents the side walls from ever having a higher temperature than 200 degrees F. The high-temperature chamber is heated to 2300 degrees F. from the normal room temperature in one hour and forty-five minutes. Approximately 410 cubic feet of gas per hour is consumed in heating to this temperature, and 260 cubic feet per hour is required for maintaining it.

Heat-treating Angle-iron and Carbon Steel Pieces

Specimen angle-iron pieces, highly polished prior to heating, were held at 2000 degrees F. for ten minutes in a carbon monoxide atmosphere, and immersed in oil. These specimens came out with a surface clean from scale or oxide and the polishing marks clearly visible. In the following experiments, the specimens were heated by placing them consecutively in the three chambers. A carbon steel die was heated to a temperature of 1540 degrees F. in a carbon monoxide atmosphere, and held at that temperature for four minutes. After immersing in oil and withdrawing, the surface of the hardened die was found to be without scale and purplish-black with gray spots. A similar die was also successfully hardened by heating in a chlorine gas atmosphere and immersing in water. This die had a clean surface of a light gray color with some purple spots.

The two dies were put to work after very little stoning, and while the production from these dies was excellent, it was not exceptional. Later tests indicated that, owing to the unusually clean surfaces, dies hardened by these methods would cut tissue paper without stoning in some cases and with very little in others.

Several high-speed steel double-end boring tools, 3/4 by 1 3/4 by 8 inches, were held in the high-temperature chamber for four minutes in a carbon monoxide atmosphere. These specimens came out clean without being blistered or oxidized, and were gray in color. They looked like steel taken from an acid cleaning bath, having a stained but smooth surface. These tools had been surface-ground all over before hardening. When fractured, the grain showed velvety throughout, and was beautiful in appearance. Only one make of steel was used for these cutters.

High-speed steel end-mills of different makes were heat-treated in accordance with the hardening instructions of the steel manufacturer in each case. Specimens of one make of steel were hardened in a carbon monoxide atmosphere by keeping them in the high-temperature chamber for 4 1/2 minutes and quenching in oil. They were tempered at 1050 degrees F. Specimens from another lot of the same make of steel were held for various lengths of time— from four to fourteen minutes—in the high-temperature furnace and quenched and tempered as before. In each case the specimen hardened clean, without scale, and was black in color.

Some of the end-mills in the first lot were extraordinary in cutting ability. This was likewise true of some held in the high-temperature chamber for a longer period. End-mills made from some other makes of high-speed steel were treated with as good results; however, certain makes would not harden at all. Some steels would harden only in spots, but this was probably due to the method of holding the piece,

or because it was not agitated sufficiently while in the high-temperature chamber to heat it uniformly. During these experiments the temperature of the high-temperature chamber varied only 15 degrees, as shown by two thermocouples which were moved to different positions in the chamber. Many high-speed steel hobs were tried with practically the same results, that is, those made from certain steels would harden with a clean surface, while others would not harden, although the temperature chamber was varied from 2250 to 2450 degrees F.

Conclusion

The high-speed steel specimens that would not harden when heated to the specified temperatures in the presence of certain gases, and especially carbon monoxide gas, would harden by quenching after being heated in an open coke fire, coal fire, semi-muffle gas furnace or oil-fired furnace. The writer tried discharging hydro-carbon gases in the intermediate- and high-temperature chambers, and whenever this was done he was able to harden any make of high-speed steel. However, there is an objection to the use of these gases, because at the high temperature of about 2300 degrees F., the carbon disassociates from the gas and floats about in the form of a black cloud, which hides the work. This objection may not be serious, but it is always preferable to see the work. It was found impossible to produce scale on a specimen piece, no matter how long it was left in the high-temperature chamber in the presence of these gases. Among the hydro-carbon gases, ordinary coal gas was used. This gas gave almost as clean results as some of the other gases. Chlorine gas was also discharged into the chambers for some high-speed steel parts, but at the high temperature employed, this gas becomes so dangerous that the experiments with it were discontinued before anything valuable was determined.

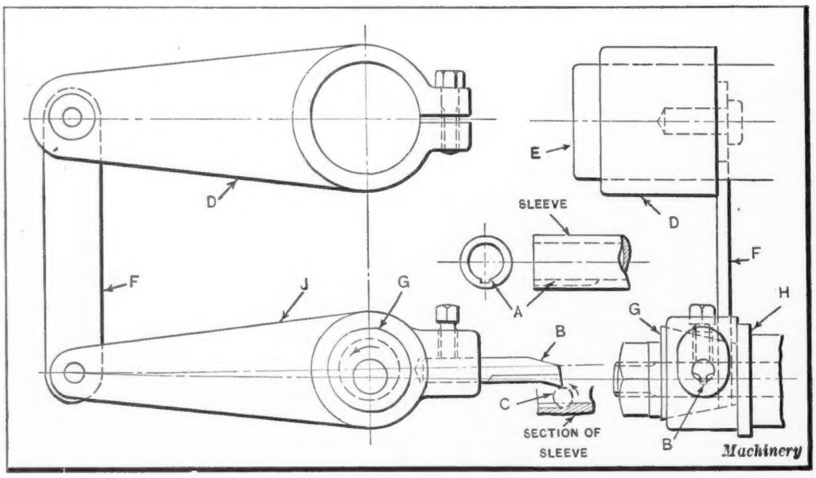
In conclusion, these experiments would indicate that the mere heating of some makes of high-speed steel to certain temperatures, and cooling, will not harden them; that some high-speed steels will remain soft when heated to the so-called hardening temperature in the presence of carbon-monoxide gas and cooled in oil; and that other experiments should be conducted to determine the different atmospheres necessary (preferably the one atmosphere) to enable any make of high-speed steel to be hardened.

* * *

KEYWAYING ATTACHMENT

By E. M. LONG

A milling machine attachment designed by the writer for use in cutting keyways on the inside of small steel sleeves is shown diagrammatically in the illustration. The keyway, which is indicated at *A*, is 1/8 inch wide, 0.070 inch deep and 7/8 inch long. The sleeves are of steel, and are bored out to a diameter of 5/8 inch. In cutting the keyway, the point of tool *B* follows the path indicated by the dotted line at *C*, the cutting action being similar to that of a fly cutter.



Side and End Views of Keyway-cutting Attachment

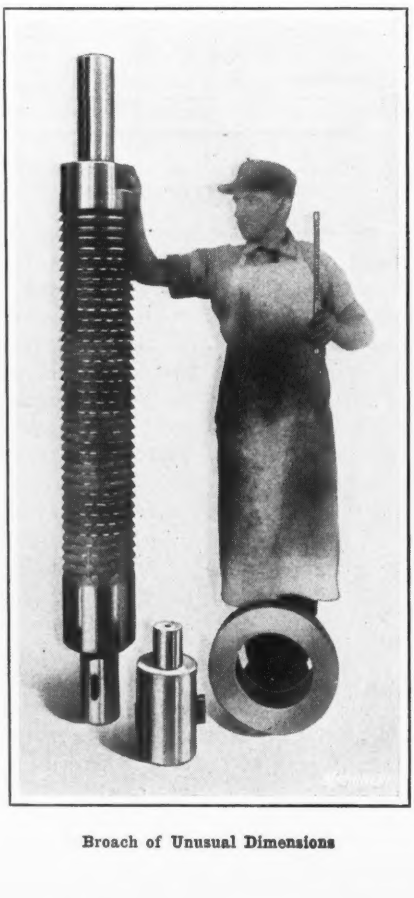
The attachment consists primarily of the over-arm pendant *D*, attached to the regular over-arm *E* of the machine, a link *F*, and a cast-iron tool-holder *J*. A hole is bored through the tool-holder to fit the taper of the eccentric *G*. This eccentric, with its special washer *H*, is mounted on the regular milling machine arbor. The link *F* supports the outer end of the tool-holder. By running the milling machine spindle in the direction indicated by the arrow, the working point of the tool is made to follow the circular path indicated by the dotted line *C*.

The time required to cut a keyway is about one minute. The sleeve is held in a special chuck mounted on a regular milling machine vise. The table of the milling machine is fed forward, the same as when using a regular milling cutter, and the spindle is run at a speed of approximately 400 revolutions per minute. The keyways cut with this attachment are practically free from burrs.

* * *

BROACH OF EXTRAORDINARY SIZE

What is believed to be the largest broach of its type ever made has recently been produced in the shops of the J. N. Lapointe Co. New London, Conn., for broaching roller bearings used on freight cars and locomotives. The accompanying illustration gives an excellent idea of its size. It is about 7 feet high, 9½ inches in diameter, and weighs approximately 900 pounds. The bushings that are broached by means of this tool are made of chrome-nickel steel, the broach removing about 1/8 inch of metal on the diameter.


Broach of Unusual Dimensions

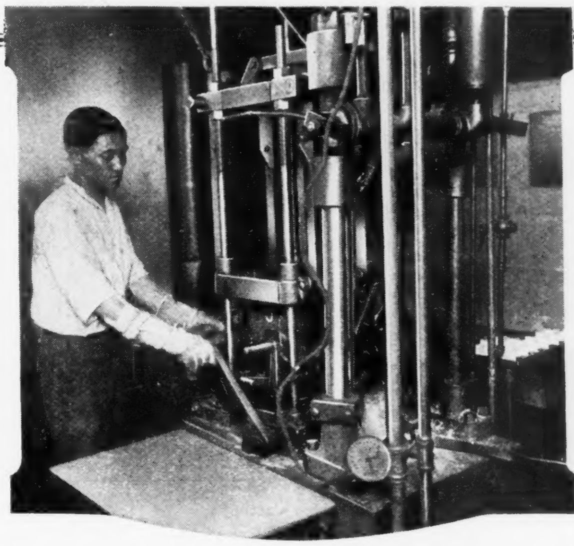
The broach is made up in sections of four teeth each, and these sections are put on an arbor that is ground true, so as to insure that the broach will cut round holes with accuracy. The weight of the broach is compensated for by means of a special fixture attached to the face of the broaching machine. This fixture slides on a way that is lined up with the pulling head of the machine. The production obtainable with this broach is from 20 to 25 bushings per hour. The broach is used on the No. 5 machine built by this company.

* * *

The Diesel engine is becoming well established for ship propulsion. There are now more than 130 vessels of over 2000 tons driven by Diesel engines, 78 of these (aggregating over 500,000 tons) being equipped with Diesel engines built according to the system of Burmeister & Wain, Copenhagen, Denmark.

Types of Die-casting Machines

By CHARLES PACK, Vice-president and Chief Metallurgist, Doehler Die-Casting Co., Brooklyn, N. Y.



ALTHOUGH many types of die-casting machines have been used in different stages of the development of the die-casting industry, those now in general commercial use are either of the plunger type or of the compressed air type.

A diagram of the plunger type machine is shown in Fig. 5. In this design, the operation of the machine is as follows: Compressed air is admitted to cylinder *A*, thus operating the rocker arm *B*, which advances a piston in cylinder *C* (located within the melting pot), and forces the molten metal up through the nozzle into the dies, clamped in a framework directly above the nozzle. The cylinder *C* is submerged in the molten metal to the depth shown by the dotted line. On the release of the piston, the metal flows by gravity through a slot in the end of the cylinder until it reaches its own level. Thus, with every release of the piston, the cylinder is refilled, preparatory to the next stroke.

The dies are aligned on four posts of the framework, which is hinged to the machine so that it may be thrown into a horizontal position for opening and closing the dies. A view of the plunger machine with the carriage tilted back and the dies opened is shown in Fig. 1, and the same machine with the frame clamped in its vertical position over the melting pot is shown in the heading illustration. As soon as the cast has been made, the frame is unlocked by means of the handle at the front of the machine, and thrown back on its hinge where it is supported by a floor stand. The long lever *A*, Fig. 1, opens the dies through toggles *C*, and the various handles on the upper or ejector die are used to withdraw the cores and advance the ejector-pins after the dies are opened.

After the casting has been ejected, the dies are closed, the cores adjusted, the ejector-pins withdrawn, and the carriage raised to its vertical position with the aid of an air hoist connected to the frame by rod *B*. The hoist is allowed to swing as the frame is raised. The dies are then clamped over the nozzle *D* of the melting pot, after which the machine is once more in readiness to make a casting.

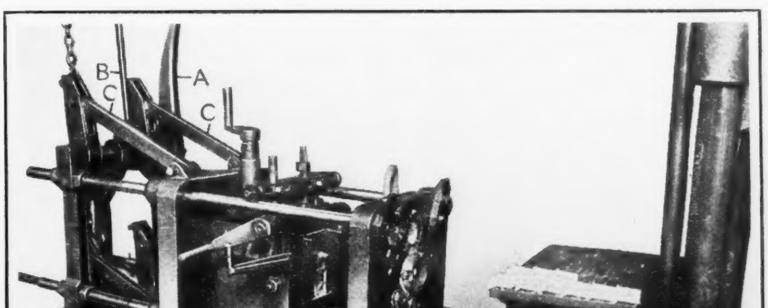


Fig. 1. Plunger Type Die-casting Machine with Die Carriage hinged back, showing Melting Pot and Carriage Lock

The compressed-air machines, that is, those in which compressed air is applied directly to the molten metal to force it into the dies, are of two types—the valve type shown diagrammatically in Fig. 3, and the gooseneck type shown in Fig. 4. The valve type is not extensively used at present by the company with which the writer is connected, the plunger type and the gooseneck type machines being preferred. The valve-type air-pressure machine consists of a bell-shaped container *A*, Fig. 3, which contains molten metal to about the level shown by the dotted line. A valve stem is operated through the container by the long lever shown.

The dies are placed directly beneath the nozzle of the container, and the air valve is opened after the valve stem has been raised, so that the metal is forced through the nozzle into the dies. The air pressure is then released, the nozzle closed by the stem, and the dies run out from under the machine on a track *B* so that they may be opened to remove the castings. The lever *C* actuates a clamping arrangement for raising the dies and locking them between the nozzle of the container and the clamping arrangement. The main objection to this type of machine is the fact that the valve corrodes, which causes the nozzle to leak, and produces unsatisfactory results. In addition to this objection, it is necessary to recharge the container frequently which is a rather awkward procedure, as the cover has to be removed.

Gooseneck Die-casting Machine

The gooseneck air-pressure machine is of the horizontal type. A view of the machine with the dies open is shown in Fig. 2. The special shaped air cylinder *A* (Fig. 4) is the gooseneck from which the machine derives its name. In operation, it is immersed in the molten metal, which rises to a sufficient height so that the metal runs into the gooseneck through a nozzle and fills it enough to permit the casting to be made. The incoming molten metal displaces whatever air there may be in the gooseneck, which passes out through an exhaust valve. After being filled, the gooseneck is raised until its nozzle

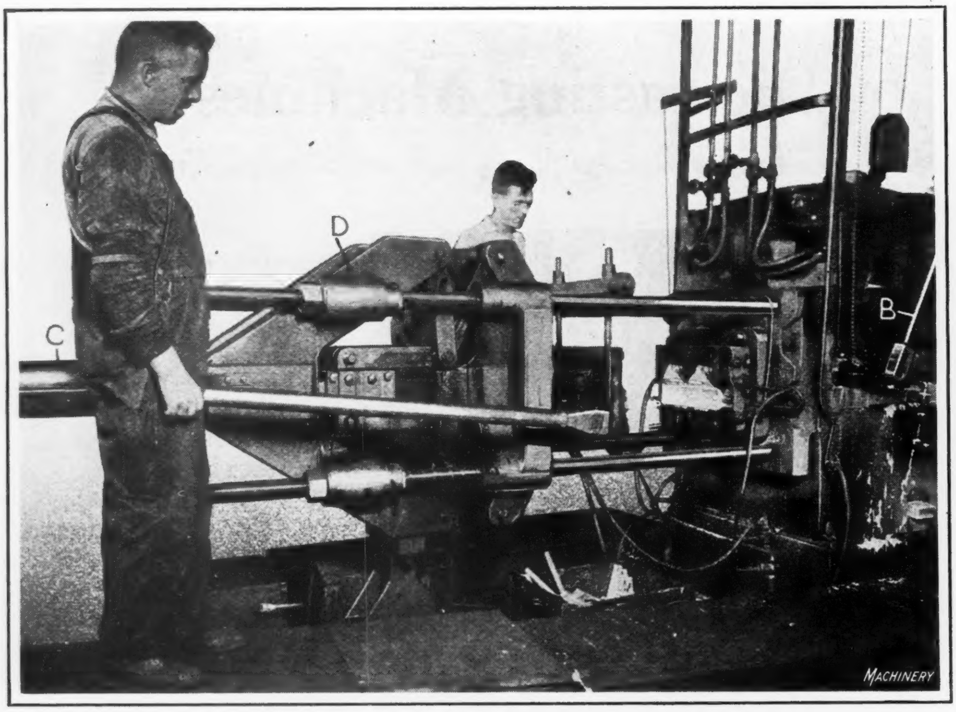


Fig. 2. Using Gooseneck Die-casting Machine for Large Castings

The amount of pressure required to make a casting depends on the design of the part: on large or intricate castings, several hundred pounds per square inch may be necessary. Upon the release of the air pressure, the nozzle is again lowered into the melting pot and the gooseneck recharged, the entire cycle of operations requiring but a few seconds. Although this type of die-casting machine has proved more efficient than any other used by the writer's company, especially for aluminum casting, even in this machine there is considerable room for improvement in design.

Machines for Large Castings

The gooseneck machines are often made in large sizes, with a melting pot of greater size than ordinarily used and two goosenecks, for making large castings. In fact, Fig. 2 shows such a design being used for casting a calculating machine case. These cases range from about 16 to 30 inches in length. In the illustration, the casting itself is shown in the die next to the melting pot, that is, in the cover die, although in actual practice the casting would be in the ejector-die when the dies are first opened.

The air valve for operating the huge toggle *D* on this machine is at the extreme left, and is not shown, although the air cylinder is indicated at *C*. At least two operators are required for each die-casting machine, so that the duties of operating the gooseneck, locking and opening the dies, ejecting the casting, adjusting the cores, etc., can be equally divided between them. It is necessary to lubricate the dies occasionally, so as to prevent the casting from sticking in the impression. For this purpose a mixture of graphite and oil is used. The operator in the foreground in Fig. 2 has one hand on the long lever arm

enters a bushing leading to the dies. The lever that raises the gooseneck and seats it tightly in this position is shown at *B* in both Figs. 2 and 4. A hook is provided on the upper part of the gooseneck for suspending it during the casting operation, which occurs when the valve in the air line is operated.

The air passes into the gooseneck through hollow link members, a construction which permits that container to be raised and lowered as described. The air is controlled by a whistle valve, which is operated by pulling a chain attached to the valve lever. The dies are attached to plates in a framework, and are clamped together by a toggle mechanism, operated by compressed air. The air cylinder is shown at the extreme left-hand end of the machine. The support for the die carriage may be moved on a track and clamped in the correct position to agree with the distance between the dies when open.

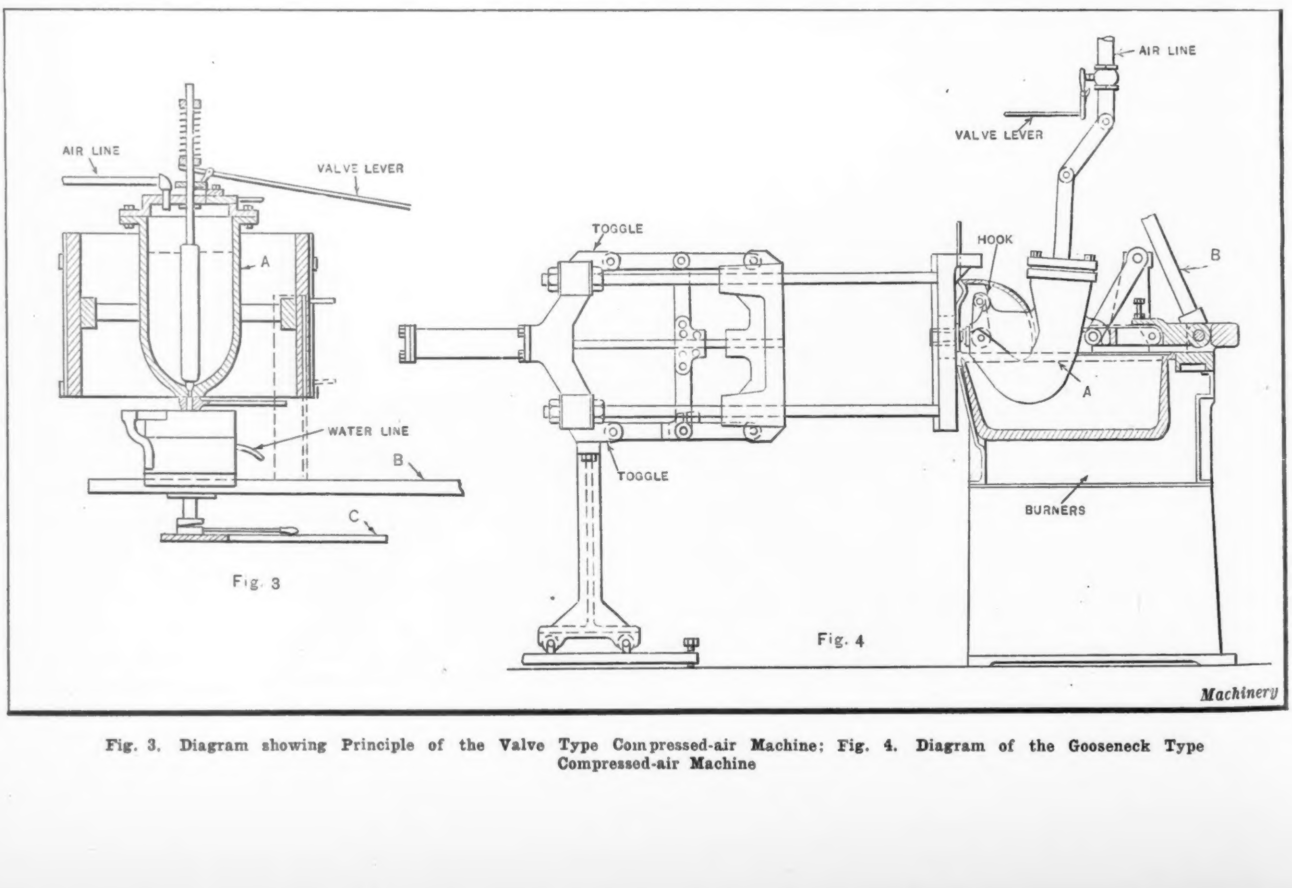


Fig. 3. Diagram showing Principle of the Valve Type Compressed-air Machine; Fig. 4. Diagram of the Gooseneck Type Compressed-air Machine

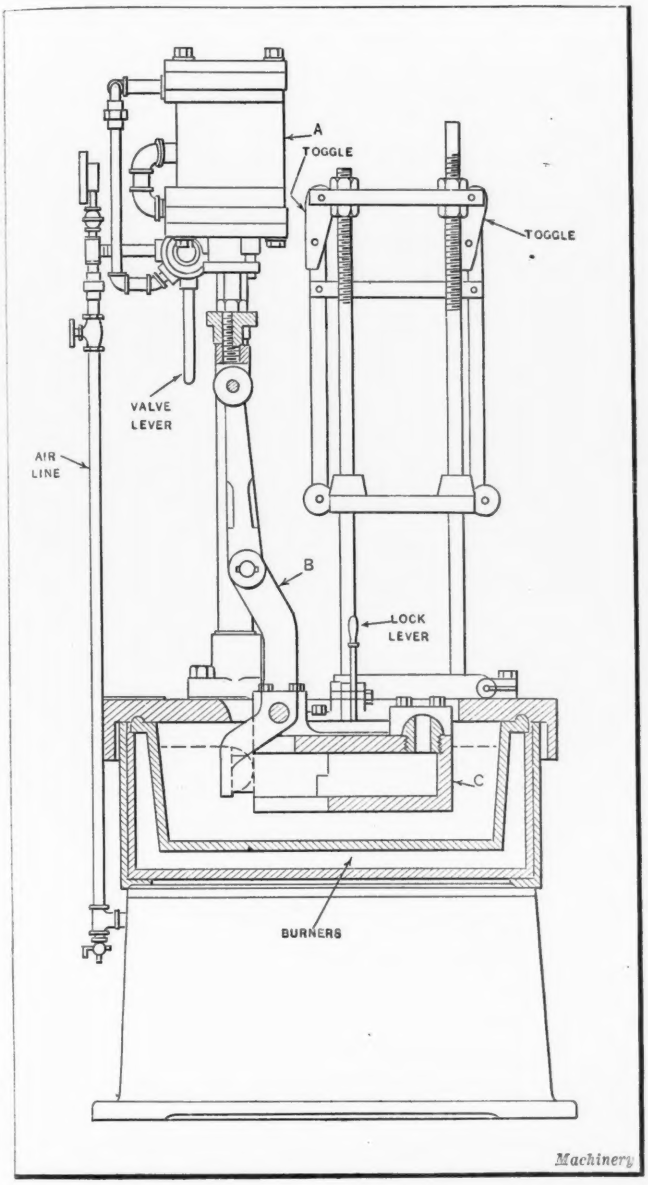


Fig. 5. Diagram of Plunger-type Die-casting Machine, with Die Carriage in Vertical Position

which operates the ejector-plate to advance the pins and remove the casting from the ejector-die.

Melting the Metal

The fuel generally used for heating the metal is gas, the burners being located beneath the melting pot, as indicated in the diagrams. For moderate sized work, the capacity of the melting pot is sufficient to melt enough metal for a large number of castings. On larger work, however, an extra pot is frequently used.

* * *

PROFILE CUTTING WITH A GAS TORCH

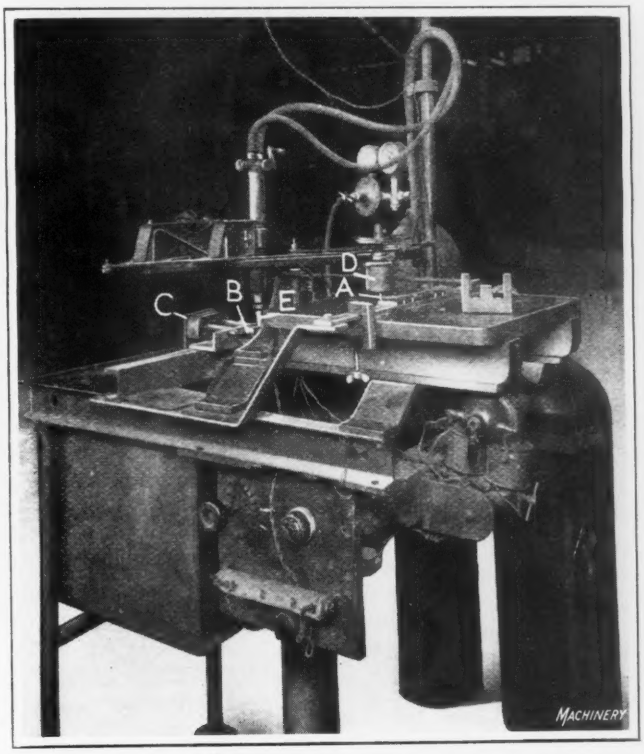
Iron cores for electric magnets used in the controlling mechanism on electric elevator switchboards constitute one class of work that is being regularly cut with an oxy-acetylene torch on the special machine here illustrated. This machine was constructed by the A. B. See Electric Elevator Co., Jersey City, N. J., for cutting out stock having an irregular outline.

A Davis-Bournonville oxy-acetylene cutting torch is used in the machine. The torch is mounted vertically in a pantograph frame, and guided, in cutting, by a master plate which is clamped to the table of the machine. The unusual feature of this arrangement is that the follower-pin *A* is magnetized, so that as it revolves it is attracted to the master plate and rolls on its perimeter instead of following in a path milled in the plate. The master plate is twice the size of the work, and is the only removable unit that is not held in place by magnetic attraction, which, of course, would require insulating the table from the rest of the machine, or using a magnetic chuck.

Cutting out a magnet core with this arrangement is a very simple operation. One of the cores is shown upright on the table of the machine and another is shown at *B* under the torch tip *E*, supported and located from the ends by pins and held thereto by the magnetic force produced by coil *C*. With the master plate clamped to the table, the current is switched on, which starts the motor and revolves the follower-pin. The follower-pin is carried on the pantograph frame, and so may be freely swung to any convenient starting point on the master. When this has been done, the rheostat is adjusted to supply the current for the follower-pin magnetic coil *D*. The revolving follower-pin is then attracted to the master plate, around which it immediately proceeds to roll. Previous to this, of course, the current for the magnet that holds the work in place has been switched on, and the cutting flame regulated. The various electric controls are mounted on a panel at the front of the machine so that they can be conveniently reached by the operator, and the motor is located beneath the table.

These iron magnet cores are ½ inch thick, and the cutting operation consumes 30 pounds of air and 3 pounds of gas, which is the standard mixture for this thickness of stock. One pipe line from each of the oxygen and the acetylene tanks connects with the combustion chamber of the torch, and the flame is impinged on the work through two small pin-holes in the tip *E*.

The apparatus, as well as the proportions of gas and oxygen used for cutting with this machine, are those furnished by the Davis-Bournonville Co., and are as follows: For ⅛-inch stock, 10 pounds of oxygen and 3 pounds of acetylene; for ¼-inch stock, 15 pounds of oxygen and 3 pounds of acetylene; for ⅜-inch stock, 20 pounds of oxygen and 3 pounds of acetylene; for ¾-inch stock, 30 pounds of oxygen and 3 pounds of acetylene; for 1-inch stock, 30 pounds of oxygen and 4 pounds of acetylene; and for 2-inch stock, 45 pounds of oxygen and 4 pounds of acetylene. For thicknesses of stock greater than 2 inches the quantities of gas and air are increased accordingly, in the same proportion.



Machine with Magnetized Follower-pin for guiding Torch when cutting Profiles

Sharpening Square Broaches

By GEORGE E. HODGES

CUTTING tools must be kept sharp to function properly. Accordingly, it is a fundamental principle of cutter design that adequate provision be made for re-sharpening. This has been done in the case of square broaches of approved S. A. E. design, but in spite of this fact, incorrect or inefficient methods are commonly employed in sharpening these broaches. While the average shop may have limited facilities for broach grinding, there is no excuse for the quite general practice of sharpening broaches by grinding the face of the teeth, especially when the established rake angle is satisfactory. Perhaps of as great importance as the maintenance of the correct rake angle (see Fig. 1) is the maintenance of the correct radius at the bottom of the tooth. The face of one tooth and the back of the preceding tooth should be tangent to this radius, so that the chip will meet no obstruction that will prevent it from curling properly. It is difficult to grind the face of a broach tooth without gouging the back of the preceding tooth or cutting the face back so that it is no longer tangent with the radius. The gouging of the teeth (due to the broach running out) which results from grinding the face, usually prevents the chip from curling properly.

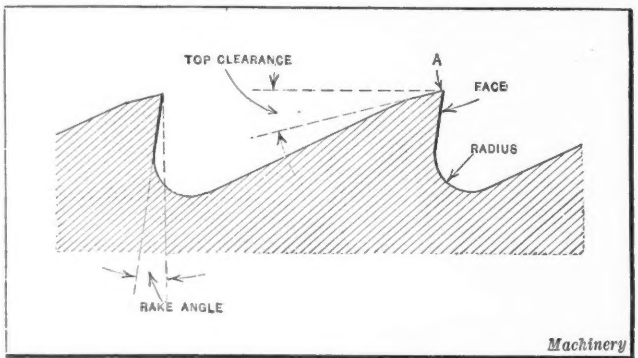


Fig. 1. Sectional View of Broach Teeth

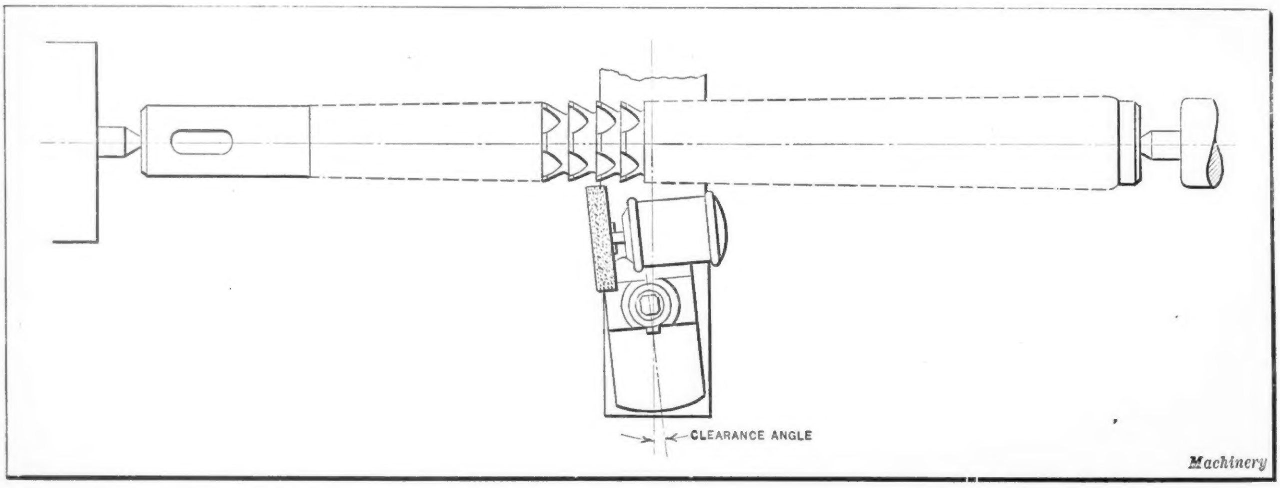


Fig. 2. Method of regrinding Tops of Worn Broach Teeth to Correct Clearance Angle

The broach teeth are worn down on the land at *A*, so that the original top clearance angle is destroyed. It is this land or top clearance that should be corrected in resharpening the broach. Ordinarily the teeth can be honed to an edge. If the land becomes too wide to permit the required clearance and edge to be readily obtained by honing, the following method may be used:

The broach is placed on lathe centers and the toolpost grinder mounted at right angles to the broach. The wheel is dressed straight across. The compound rest is then swung to the required angle, as shown in Fig. 2, the usual practice being to make the clearance angle from 1½ to 2 degrees. The compound rest is next fed in by hand until the wheel touches the high point of the tooth, after which the broach is rotated on the centers by hand, and the wheel fed in until the tooth is properly relieved. The ground teeth are finally smoothed up with an oilstone. All broaches run out or are distorted somewhat after being in use, due to the strains set up. The broach is corrected in this respect when sharpened with a toolpost grinder so that no straightening is necessary.

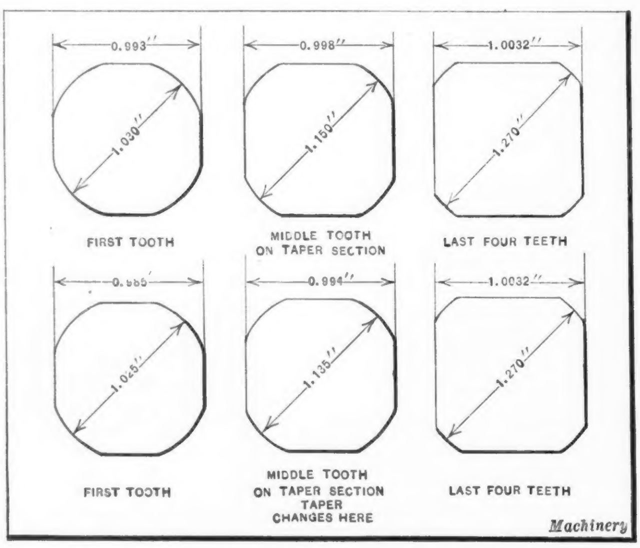


Fig. 3. Tooth Dimensions of 1-inch S. A. E. Broach before and after Grinding

The broach when received from the makers is usually proportioned as shown by the three views at the top of Fig. 3. There is a uniform taper on the corners and flats. The slight taper on the flats prevents undue drifting of the tool in the work. The advantage of a uniform taper is that such a design permits the broach to be readily retapered when necessary. Retapering is required as soon as the broach shows signs of excessive wear, which

usually appears in the form of fine grooves on the teeth at the small or starting end of the broach. This is caused by the breaking down of the teeth at this point. There are two reasons why the teeth give way at this end: First, because of the greater width of the chip taken; second, because the broach is usually less hard at the starting end than at the finishing end. The greater hardness of the teeth at the finishing end results from the fact that the thinner and narrower teeth are cooled more quickly in the quenching operation of the hardening process.

In the retapering operation, the tool is straightened carefully so that it runs true within 0.008 inch to 0.010 inch. It is then retapered on a cylindrical grinding machine, and the teeth are relieved. Two tapers are introduced, the one from the starting end being less abrupt than the one at the finishing end. This is considered good practice, as the starting teeth are required to take a wider chip and consequently the depth of cut must be less. The broach is next retapered on the flats. This is done on a surface or planer type grinding machine, using a magnetic chuck. The broach is shimmed up to give the required taper, each side being ground separately. If a magnetic chuck is not available, a pair of dividing head centers may be used. In this case, the dividing head center is raised to provide the required taper. The flats are then relieved. The three upper views in Fig. 3 show a 1-inch S. A. E. broach of the permanent fit type. The three lower views show the dimensions of the same teeth after regrinding. When it is more generally known that a liberal amount of regrinding is possible on broaches of this type, they will be more popular as production tools.

* * *

LAPPING SNAP GAGES

By CLEVE E. LONG

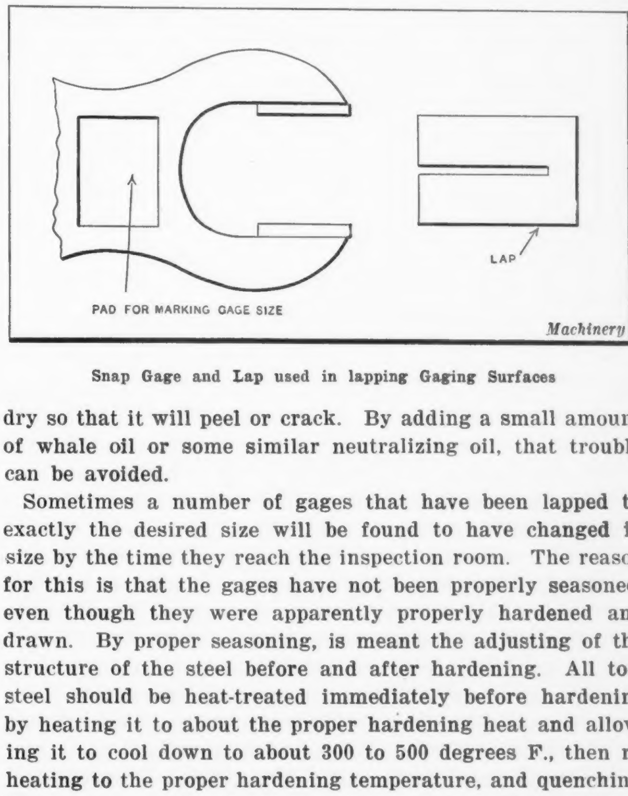
Various methods of lapping snap gages may be successfully employed. Many of the methods now in use, however, are comparatively inaccurate and needlessly expensive. It is the purpose of this article to describe a method that is so simple and reliable that it can be depended upon to give uniformly satisfactory results. The amount of stock to allow for lapping depends largely on the accuracy and quality of finish obtained by the grinding operation that precedes the lapping. Under favorable conditions 0.0003 inch should be a sufficient allowance, but the procedure would be the same regardless of the amount allowed.

As an example let it be assumed that a 1-inch gage with jaws approximately $\frac{3}{8}$ inch wide and $\frac{3}{4}$ inch long is to be lapped. The lap should be a gray iron block about $\frac{5}{8}$ inch wide and from $1\frac{1}{2}$ to 2 inches long. A slot should be cut in this block, as shown in the illustration, to allow the lapping surfaces to be sprung inward so that the lap may be entered or inserted between the surfaces to be lapped. The lap should be ground to within about 0.0002 inch of the exact size of the finished gage and then lapped to the exact size, after which abrasive or lapping dust should be rolled into the working surfaces until they become thoroughly charged. All the surplus or loose abrasive material should then be washed off with kerosene. Kerosene should also be used on the lap while rolling in the abrasive, as this aids in properly spreading and embedding the abrasive particles in the pores of the iron. A hardened roller or any convenient tool with a hardened smooth round surface can be used to press the particles of abrasive into the lap.

The slotted end of the lap is entered first between the gaging surfaces of the gage. The lap should then be moved to and fro in various directions until the amount necessary to bring the gage to the correct size has been lapped off. Usually it will be found that the gage is lapped to the desired size when the lap begins to pass freely through the gage due to the abrasive having become worn down. Thus it may be said that the lap, in a way, serves as a master gage or size block. It is very important that the lap be kept constantly wet with kerosene so that there will be no clogging of the cutting edges of the abrasive. This type of lap can be recharged as often as necessary. In the method described many gages can be lapped with the same block, because no loose particles of abrasive are allowed to remain on the lap which would wear or cut it down. This explains the necessity for washing the lap frequently with kerosene.

Less skill is required in using this method than in any other with which the writer is acquainted. With this method the surfaces of the gage can be made as smooth and as nearly parallel with each other as the surfaces on commercial gage-blocks of the most accurate type. Good workmen should be able to lap more than two dozen snap gages of the size referred to, in a day. A simple test for parallelism of the gaging surfaces is to insert a precision gage-block of the proper size between the jaws and swivel it with the fingers. If the jaws are not parallel and flat, the block will always swivel about its own center on the highest surfaces; but if the jaws are parallel and flat, the block will swivel centrally on the gaging surfaces.

The constant use of raw kerosene in lapping sometimes causes the skin on the fingers of the workman to become



Snap Gage and Lap used in lapping Gaging Surfaces

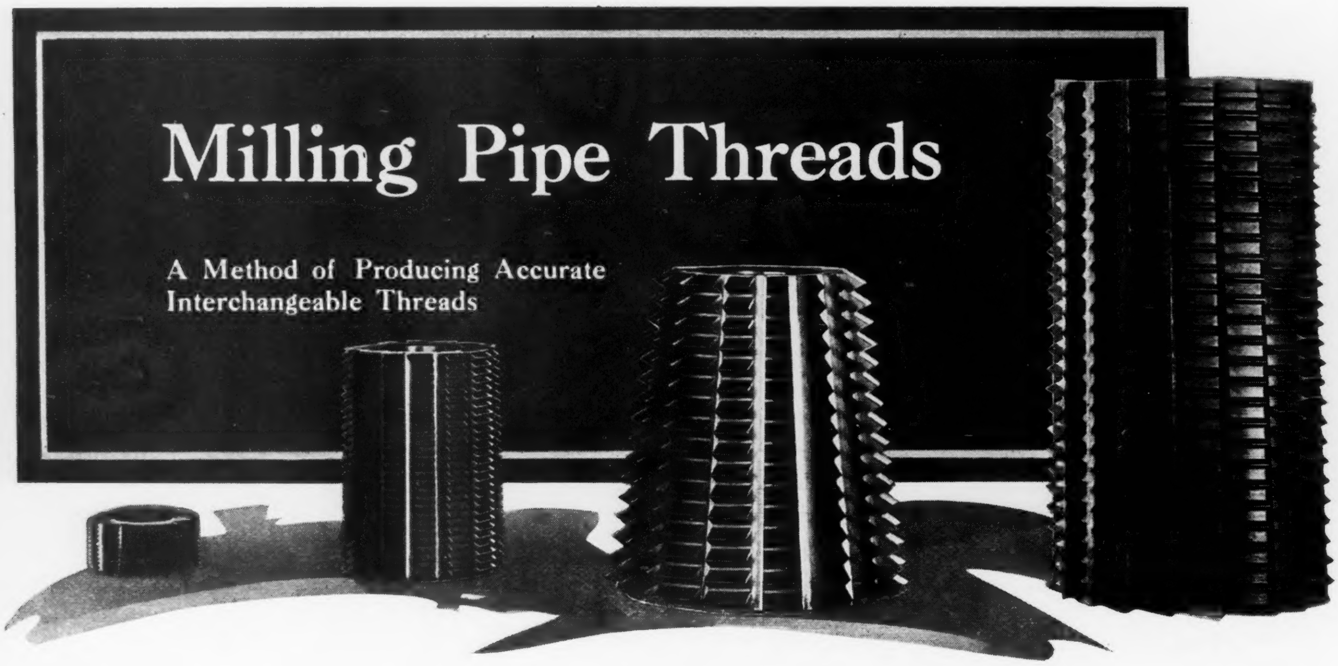
dry so that it will peel or crack. By adding a small amount of whale oil or some similar neutralizing oil, that trouble can be avoided.

Sometimes a number of gages that have been lapped to exactly the desired size will be found to have changed in size by the time they reach the inspection room. The reason for this is that the gages have not been properly seasoned, even though they were apparently properly hardened and drawn. By proper seasoning, is meant the adjusting of the structure of the steel before and after hardening. All tool steel should be heat-treated immediately before hardening by heating it to about the proper hardening heat and allowing it to cool down to about 300 to 500 degrees F., then reheating to the proper hardening temperature, and quenching. The result of this adjusting of the structure of the steel is obvious, but too many workmen fail to recognize this important factor in hardening, which is necessary to relieve the strains that cause the warping and cracking of so many expensive tools.

If the gages are to hold their size under all conditions they should be seasoned, after hardening and drawing, by being subjected to a number of changes in temperature. The change in temperature should not be great enough to affect the temper of the tool, but should be sufficient to cause the tool to expand and contract as much as possible and as often as conditions and time permit. In this way the strain left by hardening will gradually be relieved before the finishing operation. Certain manufacturers of accurate angle-plates, surface plates, etc., take a roughing cut on their castings and then place them in the open where they are subjected to the action of the sun and rain for several months in order that the strains in the metal may be relieved. This method would also serve in the case of gages if time permitted.

Milling Pipe Threads

A Method of Producing Accurate Interchangeable Threads



By JOHN D. SPALDING, Engineer, Pittsburg, Pa.

THE production of accurate interchangeable threads is of great importance in the pipe manufacturing industry. Practically all pipe, as well as couplings, flanges, and valve fittings of various kinds, must be threaded. In the manufacture of oil-well supplies, accurate threads must also be cut on tool joints, drive shoes, packers, and similar equipment.

Accurate Pipe Threads Necessary

A pipe screw thread serves not only as a fastening but also as a seal or joint which must prevent leakage under any pressure that the pipe itself will withstand. This requirement alone demands an accurate thread. The solution of the manufacturing problem of producing interchangeable pipe threads is rendered more difficult by the fact that practically all pipe threading must be done without a coordinated system of gaging or inspecting, such as would be possible if all the parts to be assembled were threaded in one plant. The need for perfect interchangeability of all pipe threads can be appreciated in considering a large power-house construction job, where the pipe may have been made and threaded by one company, the valves and fittings by another company, and the pipe flanges by a third company.

At present, dies and taps are the universally accepted standard tools for threading pipe. The development and refinement of this type of equipment has resulted from the need for intensive production, and the introduction of automatic screw machines and turret lathes unquestionably accelerated developments in the design and manufacture of thread-cutting dies.

The basic principle of all pipe threading by means of a die is illustrated diagrammatically in Fig. 1. Each blade or chaser of a die is essentially a lathe tool, as will be evident by referring to the side view of a chaser shown at *A*. As many chips are taken by a chaser as it has teeth engaged in cutting the metal. Pressure is constantly exerted against each blade, not only in the direction opposite that of rotation, but also in the direction of the feeding movement. The result is that the chaser breaks the chips into a number of layers or laminations. This breaking up of the chips is a source of heat generation, and unless a stream of lubricant or coolant is delivered to the work under pressure, considerable trouble from overheating is likely to occur.

The continuous cutting action of the chaser is confined largely to the first two or three teeth, so that the other teeth serve mainly to clean up the sides of the groove formed by the first teeth. Even with a die of the most improved design, it is evident that the cutting speed is limited by the amount of heat generated; but with a properly designed die, operated at the correct speed, and with a good supply of lubricant, a good thread is obtained.

Cutting Pipe Threads by the Milling Process

The art of milling a thread has long been known, but only recently have efforts been made to develop a machine especially for pipe thread milling. In view of the fact that thread milling is a comparatively new development, a brief description of the principles involved will be given. To the writer's knowledge the largest thread milling machine that has yet been placed on the market is shown in Figs. 2 and 3. This machine was designed under the direction of P. W. Martin, chief engineer of the Smalley-General Co., Bay City, Mich., and the writer, who was at the time chief drafts-

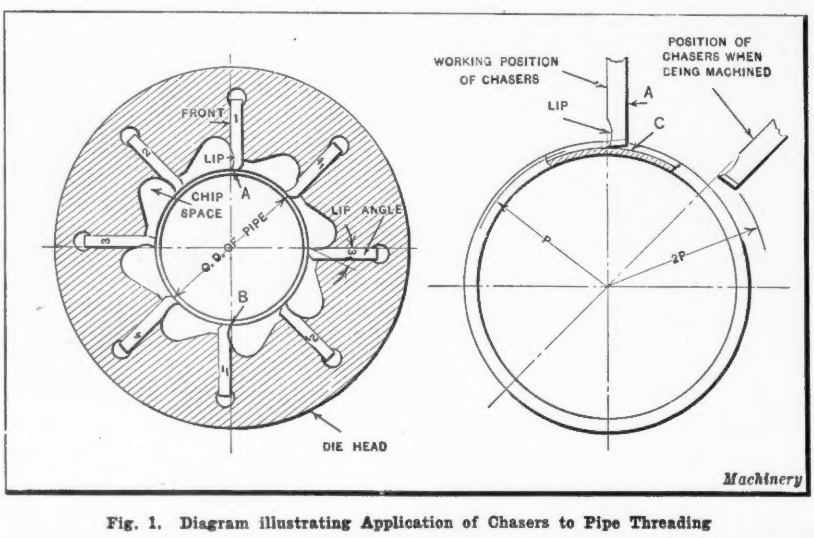


Fig. 1. Diagram illustrating Application of Chasers to Pipe Threading

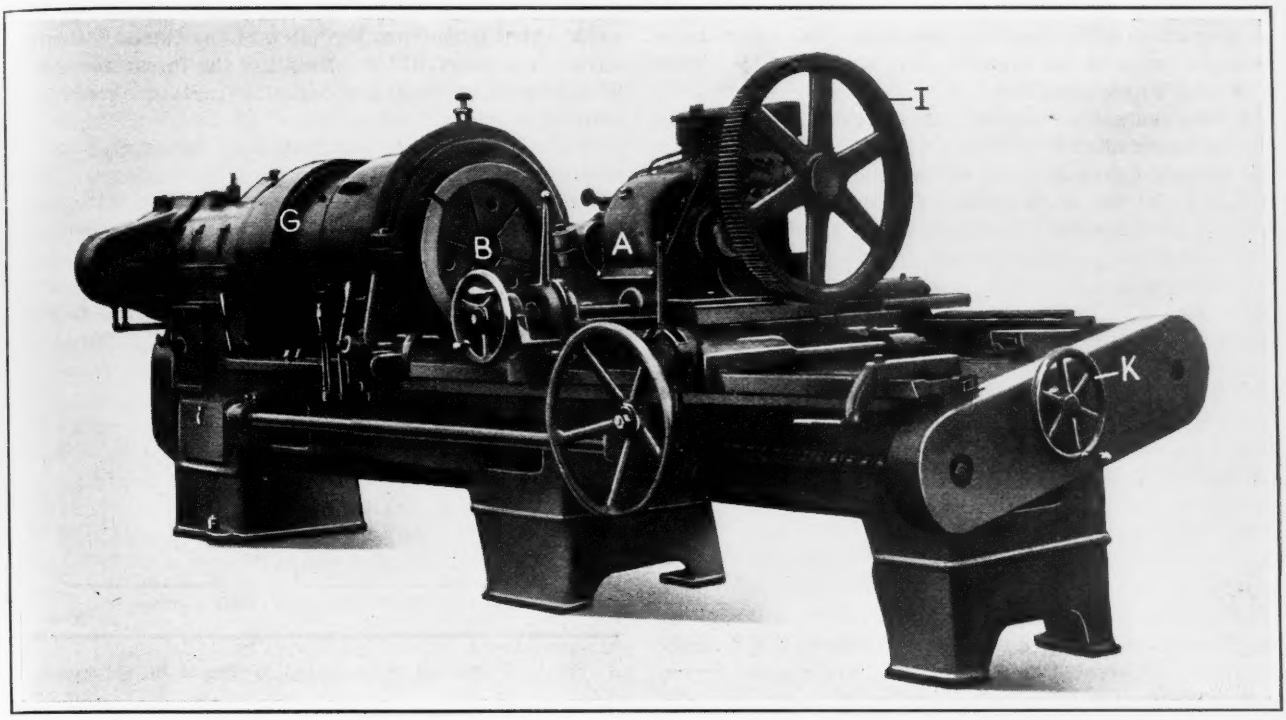


Fig. 2. Thread Milling Machine designed for threading Pipe of Any Length and Any Size up to 10 Inches in Diameter

man of that company. This machine was not designed for pipe threading exclusively, but was intended to handle the general class of heavy work encountered in the oil-well supply industry.

Machine for Milling Pipe Threads

The machine shown in Figs. 2 and 3 is similar in appearance to a heavy-duty lathe except for the milling head *A*. It consists of two basic elements, namely, a power-driven spindle with a chuck *B* for gripping and rotating the work, and a separate power-driven milling spindle *C*, in which is fixed the cutting tool or hob. The chuck is bolted to the flange of the spindle *D*, the free end running in a steadyrest or front bearing. The chuck consists of a sliding collet operated pneumatically by double-acting cylinders, the position of which is indicated at *E*, Fig. 3.

The longitudinal movement of the collet is obtained through a ball-bearing equipped yoke *F*, which transmits the motion of the air cylinder pistons to a draw-pipe, screwed into the spider of the collet. With this arrangement, it is possible to insert the pipe through the rear end of the machine and so handle work of any length. The chuck is capable of taking any length of pipe and all sizes up to 10 inches in diameter, the various diameters being provided for by using stationary collets bored out to the required sizes.

The machine is completely motor-driven. One motor drives the chuck through a series of reduction gears to the herring-bone gear *G* on the chuck body. The other motor is mounted on the milling head *A* and drives the gear *I* which, in turn, rotates the milling spindle *C*, in which is mounted the hob. The motors are not shown in the illustrations. The milling head *A* is mounted on a carriage *J*, which has a longitudinal

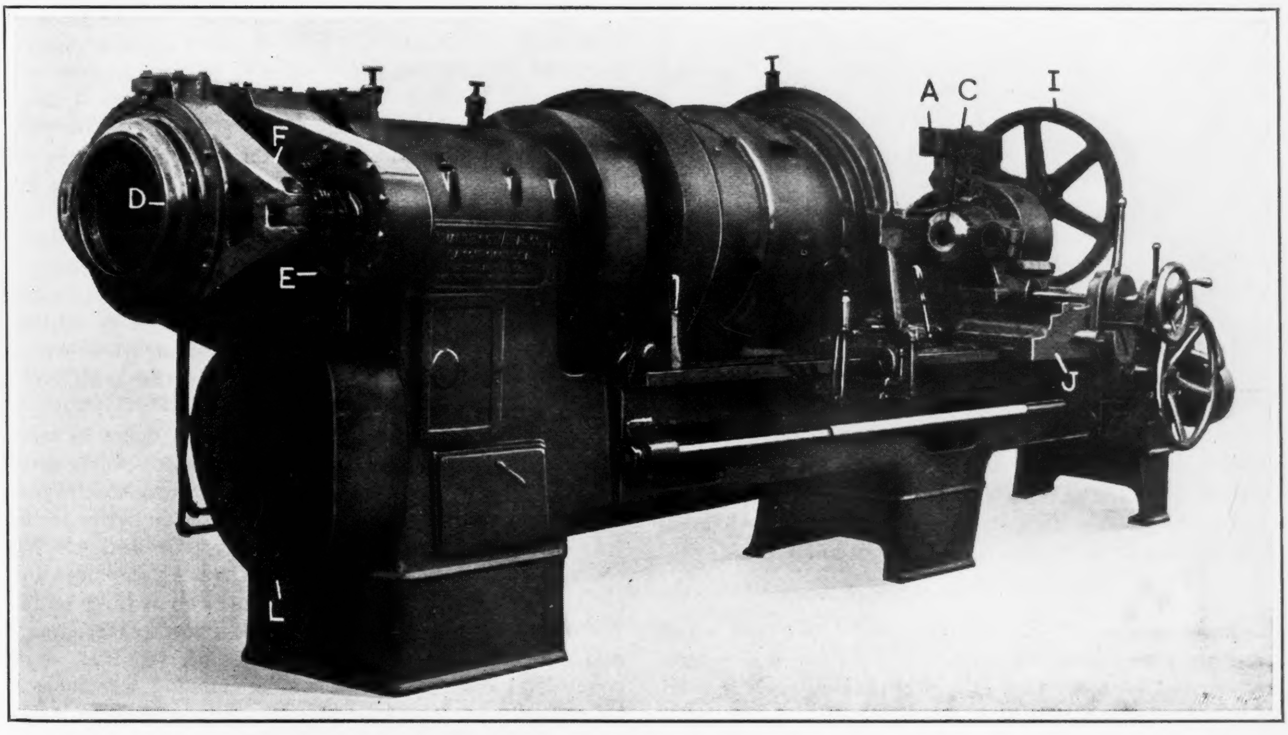


Fig. 3. View of Pipe Threading Machine showing Position of Air Cylinders E that operate the Chuck

movement with respect to the axis of the machine spindle. The cross-travel adjustment of the milling head which determines the depth of the threading cut is effected by a feed-screw with a graduated dial.

The longitudinal movement of the carriage is obtained by a mechanism similar to that used on lathes. The lead-screw *K* is connected through a set of change-gears (contained in housing *L*) to the main spindle *D*. Instead of the usual split nut arrangement, a patented clamp tube is employed on the lead-screw, at one end of which is a nut which engages the lead-screw thread. When no thread is being milled, the tube rotates with the lead-screw. At the instant that it is desired to start the milling operations on a thread, a lever on the carriage is moved, which causes a clamp to tighten around the tube, thereby preventing it from rotating and causing the lead-screw to impart movement to the carriage. A rapid traverse feature is incorporated in the machine so that the carriage may be quickly moved into place and returned to the inoperative position when the operator is putting in or taking out the work.

Types of Threading Hobs

The relative positions of the hob and the work in milling a pipe thread are indicated diagrammatically in Fig. 4. Hobs for milling different forms of threads are shown in the heading illustration. The hob shown at the extreme right-hand side is used for milling taps and die chasers. It will be noted that the teeth on this hob are staggered. This is common practice in making long hobs in which the torque in milling the thread would be too great if the regular full number of teeth were provided. With a hob of the staggered-tooth type, only half of the full-thread length cuts at one time; consequently, the torque is reduced by one half.

The tapered hob shown in the heading illustration is the type usually employed in threading tool joints. The 4-pitch tapered thread of the joint shown in Fig. 5 is milled by a hob of this type. The two hobs at the left-hand side of the heading illustration are used in cutting straight threads. The rows of teeth shown on these hobs do not form a helix as a screw thread does, but a series of parallel ridges having the same cross-sectional form or profile that the screw thread has. Hobs of this kind are made approximately ¼ inch longer than the longest thread to be milled. The

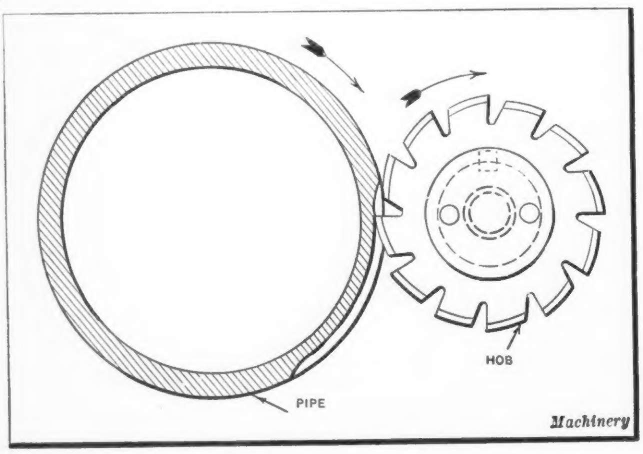


Fig. 4. Diagram illustrating Action of Thread-milling Hob

hob is rigidly secured to an arbor which fits the milling spindle *C*, Fig. 3. The pipe is inserted in the chuck through the rear end of the main spindle, a sufficient length being left projecting to allow the thread to be milled.

Thread Cut in One Revolution of Work

As previously described, the main spindle *D*, Fig. 3, which rotates the pipe during the threading operation, is connected through a set of gears to a lead-screw, which gives a longitudinal movement to the carriage and milling head. It is evident, then, that with the proper gear ratio, a longitudinal movement of the hob is obtained in one revolution of the work which is equal to the pitch of the thread. Hence, by having a hob equal to the length of the thread to be milled it is possible to produce a complete length of thread in one revolution of the pipe.

This can be readily understood by considering the construction of the hob, together with its feeding movement. At the end of one complete revolution, the thread is carried around the pipe, the portion starting from any one of the initial grooves ending at the point that was the beginning of the adjacent groove. Having considered the functional relationship of the several parts, let us refer again to Fig. 4.

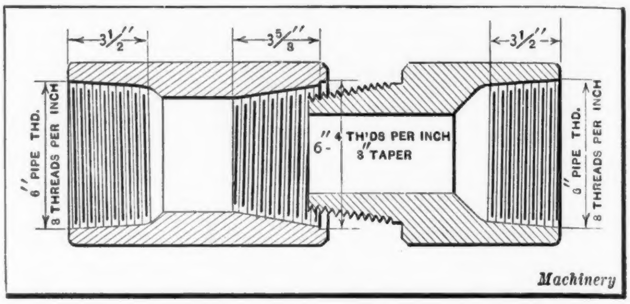


Fig. 5. Example of Work handled by Thread Milling Machine

The hob or cutter, being comparable to a cylinder of revolution, has a number of cutting teeth that successively come in contact with the pipe which is also rotated. Owing to the rotation of the hob, each tooth removes a chip as it comes in contact with the pipe. This intermittent contacting of teeth with the pipe is one of the advantages of thread milling, as the individual cutting teeth stay in the work for only a relatively short time, and then rotate through the air or stream of coolant, thus permitting the heat generated by cutting to be carried off or radiated.

Accuracy of Milled Threads

Milled pipe threads are very accurate with respect to pitch and taper. The hobs are generally made with a maximum lead tolerance of 0.0025 to 0.003 inch in a length of 1½ inches. On an 8-pitch thread this would amount to about 0.00025 inch per tooth. The lead-screw which gives the hob its required longitudinal traverse is usually of 4 pitch, or in other words, a half-revolution of the lead-screw is all that is required in milling a complete length of an 8-pitch thread.

With a possible variation of 0.025 inch in the pitch of a lead-screw in one foot, the error in lead in a half revolution would be 0.00026 inch. The taper of the hob corresponds to the taper of the work. A taper attachment of the type commonly used on lathes is provided to give the required transverse movement to the hob as it is advanced by the lead-screw. In this manner the cutting side of the hob is given a motion parallel to the thread being cut on the pipe.

The diameter of the thread is accurately maintained, as the cutter or hob is brought to the same position for every thread that is cut, due allowance being made for the wear on the hob teeth. The quality of finish obtained by milling is very satisfactory, and many tool manufacturers are now employing the thread milling process in the production of dies, taps and thread gages.

These thread milling machines can be operated by unskilled workmen, and in many instances one workman can attend to three machines. A hob is a complete threading tool. All its parts are integral, and it can be easily removed from the milling machine to permit resharpening. While one hob is being sharpened, another can be employed in its place, thereby delaying production only two or three minutes. When the hob is sent to the tool-room for resharpening, no disassembling or adjusting operations are required. A dull hob is placed on an arbor, and a grinding wheel brought in contact with the face of each row of teeth in the resharpening operation.

If a hob is of sufficient length to mill a thread on a 20-inch pipe, it may be used to thread every size of pipe below 20 inches down to pipe 2½ inches in diameter. Therefore, for any given pitch and taper of thread, it is immaterial what the diameter of the work is, so long as the hob for that particular pitch and taper is long enough to mill the longest thread required. Of course, in practice, it would be impracticable to use a hob 3 inches long to mill a thread that is only 1 inch long. In a pipe mill it would require only three or four sets of hobs to mill all pipe threads from 2½ inches up to 20 inches.

Several of the large pipe manufacturers employ thread milling machines for producing pipe thread dies and taps. In a certain plant it took an expert lathe hand approximately one day to complete a set of twelve chasers of a certain size. The time for making the chasers in a thread milling machine was found to be one-half hour or less. A special jig was made for holding the chasers, which was designed to hold twenty-four chasers, so that two sets were made in one set-up. Thus the production time was reduced to fifteen minutes per set of twelve chasers.

Proposed Method of Milling Thread Chasers

A novel application of thread milling to the manufacture of threading dies was recently suggested by Mr. Martin, chief engineer of the Smalley-General Co. One of the difficult manufacturing problems on small pipe dies with inserted chasers is that of properly machining and relieving the chasers. The difficulty is due principally to the limited working space available. It would, of course, be practically impossible to use a hob in milling a ½-inch pipe thread die by the usual method.

In order to overcome this drawback, a jig was designed to accommodate several sets of chasers. The chasers are machined in one revolution of the jig with a hob of some practical size. The lead or helix angle of a chaser is different for every diameter of pipe, and it is necessary that the helix angle be accurately maintained in milling chaser threads; a clearance such as shown diagrammatically at *C*, Fig. 1, must also be produced. In order to illustrate the proposed method of milling chasers for small pipe, let it be assumed that a jig is to be designed to accommodate two sets of chasers, each set consisting of four chasers. The die-head shown in Fig. 1 will serve to illustrate the general design of the fixture and the principle on which it operates.

In order to arrange two sets of chasers in a circle and yet maintain the original circumferential distance between the chasers on the pitch line of the teeth, it is necessary for the circle to have a pitch diameter that is twice as large as the pitch diameter of the thread the chasers are to cut. The reason for this arrangement of the chasers will be clear by referring to the diagrammatic view of the die-head shown in Fig. 1. It will be noted that the two chasers 1 and 1_1 are located diametrically opposite, as are also the three pairs of chasers 2 and 2_1, 3 and 3_1 and 4 and 4_1. Now while the spacing between a pair of chasers is equal to a half circumference, the circumferential distance from point *A* to point *B* is the same as the complete pitch circumference of the thread the chasers are to cut.

In order to obtain the proper pitch and angle of thread on each of the chasers, the hob is advanced a distance equal to the pitch of the thread while the fixture is rotated through one-half a revolution. Hence, for this particular fixture, the hob will advance a distance equal to twice the required pitch in one revolution. Thus the advance of the lead-screw in one revolution of the fixture is equal to the number of sets of chasers to be milled times the pitch of the thread, when the chasers are arranged in the fixture as shown. From the preceding description it will be clear that the threads milled on the chasers 1 and 1_1 are identical.

Each pair of chasers, as for instance the pair numbered 4 and 4_1, are also alike, so that we have two complete sets of chasers, consisting of four chasers each. Of course, the chasers are not arranged in the fixture with the cutting face on a radial line as shown in Fig. 1, but are located at a slight angle in order to produce the required clearance. Another method of producing the clearance would be to use a relieving attachment, such as that employed on a lathe. In the latter case, the faces of the chasers would be located on radial lines as shown. The writer does not know whether the method just described has been tried out, but it has been approved by several die manufacturers.

Thread-milling Oil Well Equipment

A typical threading job done by thread milling machines in the plant of a manufacturer of oil well supplies is illustrated in Fig. 5. It will be noted that two 6-inch pipe threads are specified on this tool joint. The floor-to-floor time required in milling these threads in 0.40 carbon steel is approximately seven minutes. The time required for milling the 4-pitch tapered thread (either internal or external) is from seven to eight minutes. To the writer's knowledge one company in the Pittsburg district is thread milling 6-inch pipe threads in tool joints of 0.20 per cent carbon steel and producing forty-five threads a day. Previous to the introduction of thread milling in this particular plant, when a lathe was used, only from nine to eleven threads were produced in a day.

Proposed Improvements in Pipe Threading Machine

A few engineers experienced in the design of the larger types of thread milling machines have given some attention to the development of a more advanced type of machine which will meet especially the requirements of a pipe mill. These plans call for two adjustable milling heads designed to thread both ends of a pipe simultaneously. All the additional tooling for cutting off the pipe to length, and chamfering the end while the thread is being milled could be incorporated in the new machine. It will be remembered from the foregoing explanation of thread milling practice that the pipe thread is completed in one revolution of the pipe. Therefore, it would be possible to mill the thread and chamfer the inside edge of each end of the pipe in one revolution of the machine spindle.

Some interesting tests were recently made at a large steel plant with the object of comparing the accuracy obtained by thread milling with that obtained by threading on a lathe. The tests were made on pipe of 0.40 per cent carbon which was upset for a length of 8 inches to a thickness of ½ inch. With the thread-milled pipe, the work could be held to a tolerance of plus or minus ¼ turn of the gage instead of one complete turn, as ordinarily allowed.

* * *

MEETING OF AMERICAN SOCIETY FOR TESTING MATERIALS

The twenty-sixth annual meeting of the American Society for Testing Materials will be held at the Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., during the week beginning June 25. The discussion begun at the annual meeting in 1922 on the fatigue of metals will be continued through the presentation of papers giving important new data. Several papers on testing apparatus are in prospect, including a description of a device for the accurate measurement of impact force. The new plan of distributing preprints of reports and papers to the members will be put into effect.

* * *

An International Air Congress will be held in London from June 25 to June 30, the object of the congress being to discuss the various problems connected with aircraft design, construction, and operation. Papers will be divided into four groups, dealing with different phases of the subject. Those visiting the congress will also have an opportunity to visit various British aircraft factories. Further information may be obtained from the general secretary, Lieutenant-Colonel W. Lockwood Marsh, 7 Albemarle St., W.1, London.

AUTOMATIC PIERCING AND BLANKING DIE FOR WASHERS

By G. R. SMITH

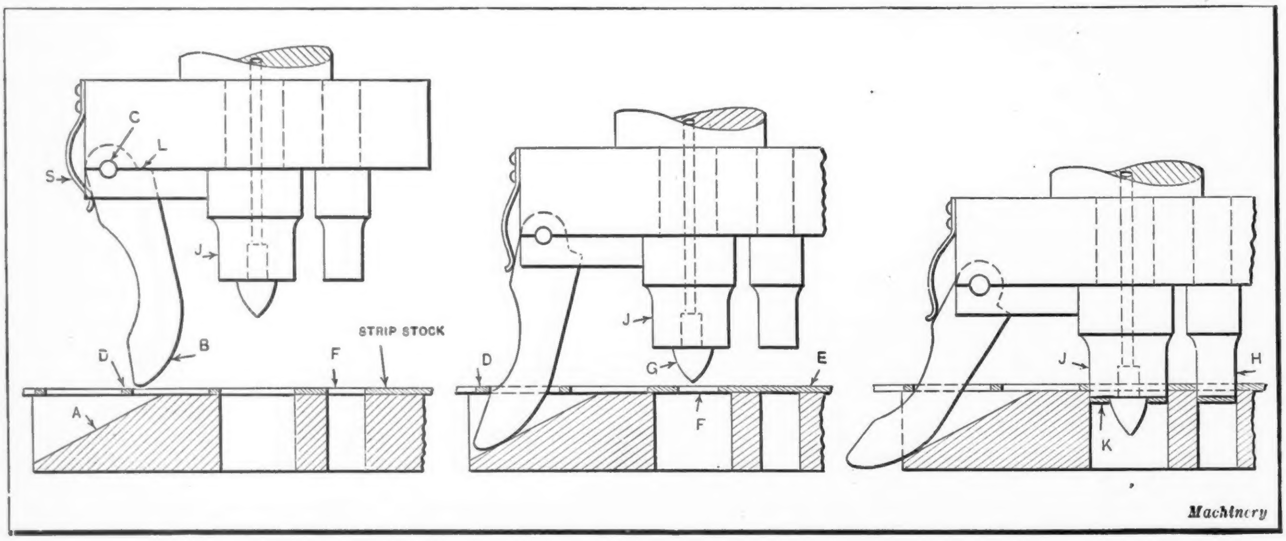
A progressive type of piercing and blanking die was described in November MACHINERY on page 223. The same type of die equipped with an automatic feeding device is shown diagrammatically in the illustration. This type of die can be operated automatically in a single-action press such as the Bliss No. 20 or 21. The writer believes that the die described in November MACHINERY could be readily equipped with an automatic feeding device similar to the one here shown. The illustration is intended to show the action of the feeding device, and does not represent the actual construction of the die. While this style of die is primarily intended for use in the manufacture of washers, it can also be adapted to the manufacture of various kinds of small blanks, rings, cups, etc.

The feeding device is very simple, and may be made as sturdy and strong as the work requires. It can be used on follow-dies designed to pierce and blank two, four, six, or eight washers simultaneously, or for dies designed to blank only one piece at a time, as in the case shown. Either strip or coil stock can be used. In equipping a die with this automatic feeding device, it is necessary to cut or mill a slot at an angle in the blanking end of the die, as indicated at *A*. On the down stroke of the press ram the feed-finger *B* on the punch engages the bottom of this slot, thus causing the finger to pivot about pin *C* in a clockwise direction.

The pivoting movement imparted to the feed-finger causes the front face of this member to come in contact with the bridge section *D* of the blank stock, so that the stock is fed forward into the position indicated at *E* in the central view. This brings the pierced hole *F* in the strip stock under the pilot *G* of the blanking punch. As the punch continues its downward movement, hole *F* is brought into alignment with the blanking punch *J* by pilot *G*. The view at the extreme right-hand side of the illustration shows the punch at the end of the downward stroke, at which time piercing punch *H* has pierced the central hole of another washer, and blanking punch *J* has blanked the washer *K* that was pierced on the preceding down stroke of the punch. It will be noted that the feed-finger is cut away at the front so that it will clear the bridge *D* as soon as it has advanced the stock far enough to permit pilot *G* to engage the pierced hole *F*.

The location of the feeding finger and its shape and length, as well as the angle and position of the bottom of the slot *A* in the die, must be carefully determined in order to provide the required feeding movement and insure the proper functioning of the feeding device. As the illustration is intended only to show the principle on which the feeding device operates, the actual design of the die parts may require some modification, to obtain the best results.

It will be noticed that the top of the feeding finger has a shoulder at *L*. The pivoting movement of the feeding finger in a counter-clockwise direction on the upward stroke of the ram is produced by a spring *S*. The shoulder at *L* limits the movement in this direction, so that when the punch is at the highest point of its travel, the feeding finger will be in the position shown in the view at the left-hand side of the illustration. In starting the press, one end of the strip or coil stock is placed under the piercing punch, and the center hole of the first washer is punched. The stock is then moved forward until the center hole is located under the blanking punch, in line with the pilot *G*. After the first washer is blanked, the stock is advanced so that the blanked hole in the stock is directly under the feeding finger. The press is then set for continuous operation, and the feeding finger automatically advances the stock at each stroke of the press.



Diagrams illustrating the Action of an Automatic Feeding Device for a Follow-die

* * *

PREVENTING STEEL FROM WARPING DURING THE HARDENING PROCESS

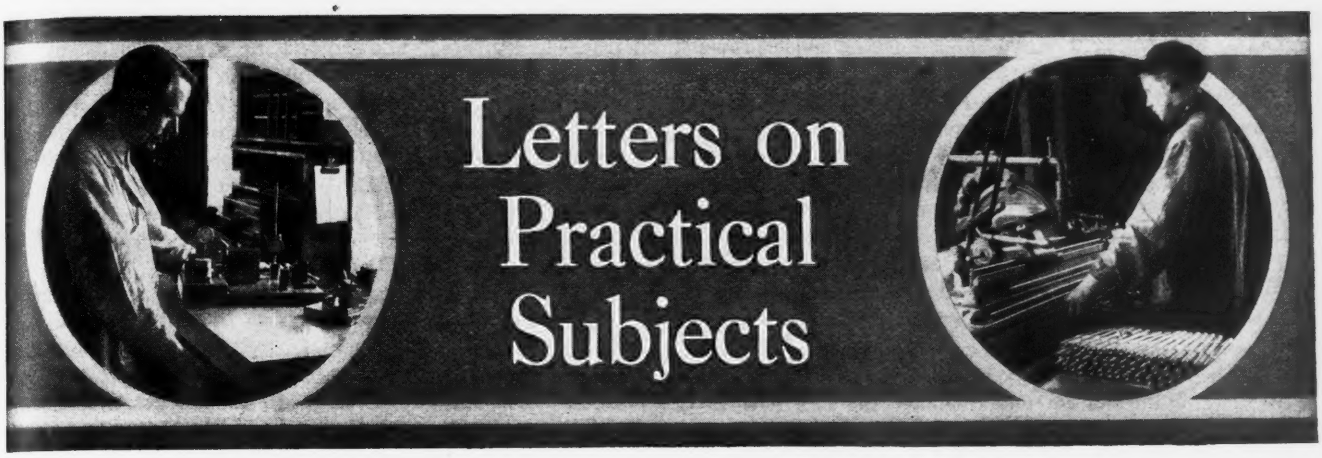
By J. H. BEEBEE

Difficulties in preventing steel pieces from being distorted or warped during the hardening operation were overcome by the writer in the following manner: The piece was first heated to a cherry red and allowed to cool in the air. It was then heated to the point of decalescence, and plunged into the hardening bath. Apparently, after the metal has been forged or machined, there are molecular strains in the steel which are removed to a great extent by the initial heating and cooling.

The writer has found that some practical machinists and graduates of technical schools are not familiar with this method of preventing warpage in hardening steel pieces. When the method described was used in hardening a mandrel 8 inches long having a diameter of ½ inch at one end and a diameter of 3/16 inch at the other, it was found that the piece was not more than 0.002 inch out of true after the hardening operation.

* * *

The industrial importance of Sweden and Norway depends largely upon the abundant water power in both countries. In Sweden there is over 6,000,000 horsepower available, of which only 20 per cent has been made use of. In Norway there is over 12,000,000 horsepower available, of which only 10 per cent is being used. Important railway electrifications are under way and plans are also being made for the "exportation" of electrical energy from both Norway and Sweden to Denmark.



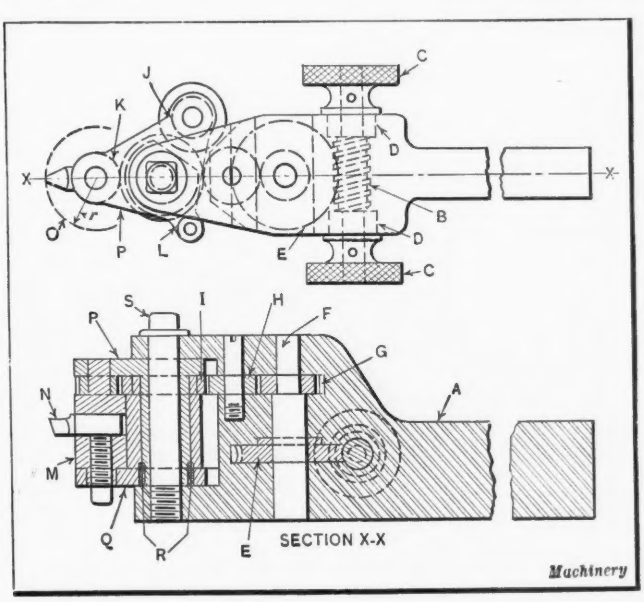
RADIUS-TURNING TOOL

The tool shown in the accompanying illustration is designed for radius-turning operations on a lathe, or radius-grooving operations on a shaper. It has a capacity for turning radii from 5/32 inch to 1½ inches and over. Provision is made for using three sizes of tool bits. When desired, the holder can be used on a surface grinder for forming or cupping out the periphery of the grinding wheel, by inserting a truing diamond in the tool-bit holder. The tool is fed through a worm and worm-wheel, in combination with spur gears. This arrangement gives a uniform feeding movement, and prevents the tool from jumping or digging in. The type of radius-turning tool shown is particularly well adapted for use in making forming cutters, as it can be adjusted to take as fine cuts as desired.

The holder *A* is made of machine steel, and is finished all over. A steel worm *B*, which can be rotated by turning one of the knurled nuts *C*, is mounted in cold-rolled steel bushings *D*. Worm *B* meshes with a bronze worm-wheel *E* on shaft *F*. A spur gear *G*, also mounted on shaft *F*, meshes with an idler gear *H*. This gear drives gear *I*, which, in turn, meshes with three other gears, *J*, *K*, and *L*. Each of the latter gears is mounted on a tool-bit holder. As shown in the illustration, gear *K* is mounted on the tool-bit holder *M*. It is apparent that by turning the knurled-head screws *C*, holder *M* will be revolved about its vertical axis, so that the point of the cutter *N* will turn the work to the curve indicated by the dotted line at *O*, or in other words, to the radius *r*. For turning smaller radii, the tool-bit holder on which gear *L* is mounted is brought into the position occupied by tool-holder *M*, and for larger radii the holder on which gear *J* is mounted is brought into position.

Each tool-head is bored to hold a different sized tool bit. In the case of the radius-turning tool shown, the small tool-bit holder takes a 5/32-inch round bit, the next larger holder *M*, a ¼-inch bit, and the largest holder, a ⅜-inch bit. The tool can, of course, be made any size. The tool-bit holders are held in a member made up of the two parts *P* and *Q*, the shank of part *P* being pressed into the hole in the shank of part *Q* and held in place by small screws *R*. The tool-head holding members *P* and *Q* can be swiveled to any desired position and can be locked in place by tightening screw *S*.

William A. LaPointe
Pittsfield, Mass.



Radius-turning Tool designed for Use in the Lathe

DRILLING, BORING AND REAMING FIXTURE FOR WATCH PLATES

The production of pieces requiring a high degree of accuracy necessitates the use of accurate jigs, fixtures, and special tool equipment. A fixture designed for this class of work is shown in the accompanying illustration. This is used in machining the winding stem bearing in the plates of a watch. The construction of the watch was such that a part of the stem hole was cut out of the upper plate as well as the lower plate, although the center line of the hole did not coincide with the division line between the two plates. This feature made it advisable to machine the hole with the two plates assembled in the fixture in their proper relative positions, as shown by the dot-and-dash lines at *R* and *S*.

The stem bearing consisted of a hole 0.110 inch in diameter by about 0.30 inch deep, and a hole of 0.024 inch diameter which started at the bottom of the large hole and extended further into the lower plate to a depth of 0.10 inch. In drilling the 0.110-inch hole, metal was removed from both the upper and lower plate for a depth of 0.090 inch, but for the remainder of the distance (0.210 inch), the upper plate only was drilled, as there was a slot in the lower plate at this point.

Drilling and reaming the hole was unsatisfactory, as the drill would run out of alignment after cutting through the solid part, and the reamer, which was of the floating type, would not correct the error. For this reason, the large hole, after being drilled by drill *T*, was bored to size and reamed, after which the small hole was drilled. The tools for these operations were carried in a revolving turret in the tail-stock, both the drills and the work being revolved, but in opposite directions, in order to produce the proper cutting speed. To obtain the required degree of accuracy with respect to the position of the hole, diameter, alignment, etc., the fixture was mounted in a holder and held securely in place by a draw-in tube *B*.

A floating drive was provided for the holder in order to prevent the side pull of the belt on the driven pulley from changing the axis of rotation of the holder. The proper location of the stem hole in the watch plates with respect to the bottom side of the lower plate, was controlled by stop-pins set in the base of the fixture, while the relation of the

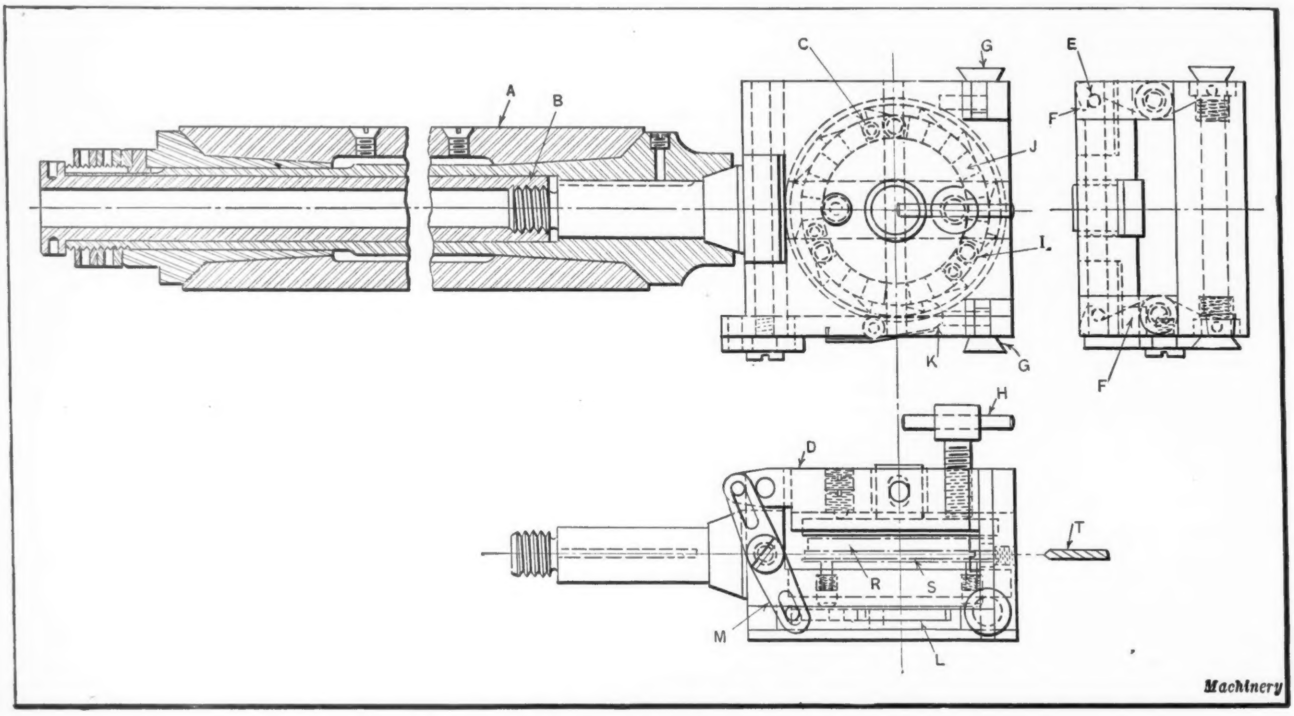
stem hole to the other holes in the plates was determined by three pins *C* which enter working holes provided in the lower plate for this purpose. These working holes were also utilized as locating points on all previous and subsequent operations on the watch plates.

Before placing the work in the jig, the two watch plates are assembled by engaging the dowel-pins on one plate in the dowel-holes of the other. The assembled plates are then placed in the fixture on the three locating pins *C*, after which the leaf *D* is closed, so that the two pins *E* are locked under the overhanging catch of the two releasing levers *F*. Levers *F* are automatically pushed outward when the leaf is closed, by the pins *E* coming in contact with the upper inclined surfaces of the levers. In opening leaf *D*, the operator's thumb and forefinger engage the two buttons *G* at the lower end of levers *F*, and by pressing these together pins *E* are released so that the leaf can be raised. After the leaf is closed, the binding screw *H* is brought into action so that the parts are securely located in the fixture. The work is then drilled, bored, and reamed.

was decided to make the body of tool steel. The body was hardened, tempered, and ground to exact dimensions, so that any distortion that took place in the hardening and tempering operations was corrected. The fixture was also subjected to a hot and cold water seasoning for a period of forty-eight hours in order to prevent distortion as the fixture aged. Approximately 1,250,000 pair of watch plates have been bored in a fixture of the design shown up to the present time. B. G. C.

INSPECTION OF RAW MATERIALS

The writer has visited many plants in which the scrap pile was loaded up with material that could either have been saved or else never put into production. In nearly all cases, work has been performed on the scrapped pieces, and they therefore represent a labor loss, as well as a loss in material. One of the many duties of a works laboratory is to act as an impartial judge in shop disputes arising over material that is spoiled in process, or that will not



Drilling, Boring, and Reaming Fixture used in machining Winding Stem Bearing of Watch

In opening the jig to remove the parts, the three ejecting pins *I*, adjacent to the locating pins *C*, push or strip the work from the locating pins. The ejecting pins are engaged by a circular cam-ring *J* in the base of the fixture, which, in turn, is operated by a pawl *K* carried by a slide *L*, which is also located in the base of the fixture. The link *M* connects slide *L* with the leaf of the fixture at such an angle that the leaf can be raised a considerable distance from the work before the cam-ring starts to operate the ejecting pins.

By the time the leaf has been opened the full distance, the ejecting pins have completed the ejection of the work and have dropped back into the next depression in the cam-ring. This action leaves the fixture free for loading without interference from the ejecting pins. The heads of these pins also act as a locking device, preventing the cam-plate from turning when the leaf is closed. This allows the pawl on the slide *L* to ride up over one tooth on the cam-ring and come in the correct position for the ejection of the next piece. The cam-ring therefore travels only in a clockwise direction.

In a fixture of this type, which is rotated at a speed of 3500 revolutions per minute, precautions must be taken to insure dynamic balance and to prevent the parts from being distorted through the action of centrifugal force. On account of the large amount of overhang of the fixture, it

conform to requirements. The laboratory should gather data, determine the cause of the trouble, and recommend changes that will prevent its recurrence. These shop troubles are often very costly, and should be carefully investigated so that they may not happen a second time. If a works laboratory did nothing more than straighten out shop troubles of this nature, it would be a paying proposition in many plants.

The acceptance of raw materials that do not meet specifications is a source of unnecessary expense or loss to many manufacturers. In fact, the financial failure of a firm engaged in the manufacture of automobile transmission units was directly traceable to the continued acceptance of material that did not meet specifications. For instance, the specifications for the countershaft gear used in this company's product called for steel having a carbon content of from 0.10 to 0.20 per cent, with 3½ per cent nickel. The heat-treatment for steel of this analysis had been carefully worked out, and a steel of a different analysis could not possibly meet requirements if given the regular heat-treatment. The steel used for these gears was obtained in the form of forgings that were supplied by a nearby shop.

When it was found that many of the gears failed on the block test and even out on the road, an investigation was made. This showed that the gears that failed were made

from high-carbon steel with no nickel content. Many of the gears cracked during the forging operation due to the high carbon content, and these cracks were not discovered before machining. After being machined, the heat-treating operations were carried out, causing further cracking of the forgings. As a result many extremely weak gears that soon failed were passed by the inspector. The heat-treatment department was held responsible for the failure of these gears, and much time and money were lost in trying to change the heat-treatment so as to eliminate the trouble.

After the presence of the high-carbon gears was discovered, it would have been a simple proposition to have applied a test to determine if each forging contained the required amount of nickel, but this plant had no works laboratory to initiate such a procedure, and so the program of scrapping gears that cost about $7 apiece continued. In a period of six months this firm put more material, by weight, on the scrap pile than it delivered to the shipping department in the form of finished products. As a result, the company soon became insolvent and passed into the hands of receivers.

A large number of the pieces scrapped were of steel in the form of stampings that failed in the drawing operations due to the fact that the steel was too hard to be drawn properly to the depth desired. Had there been a works laboratory engaged in testing the raw materials before acceptance, all material that was too hard for the required drawing operations, or otherwise unfit, would have been rejected and returned to the steel mill for credit.

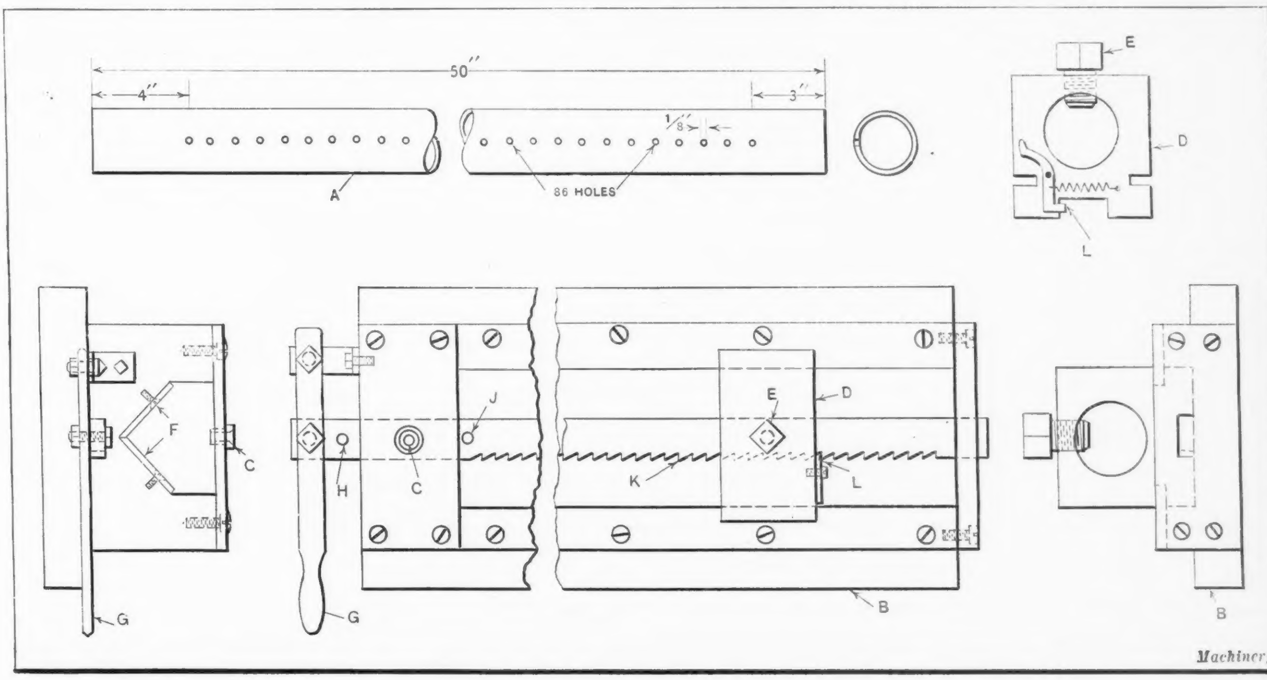
It is becoming more and more apparent to manufacturers that inspection of purchased material is necessary in order to avoid costly operations on material that will turn out to be worthless in the end. This is not because the seller intends to supply anything that is unfit for the particular purpose for which it is to be used, but because mistakes are likely to happen. In some cases, the seller may furnish material that he sincerely believes will meet requirements, but that may prove unsatisfactory because he has failed to consider or acquaint himself with every requirement of the purchaser.

Inspection of purchased materials may be made with definite ideas as to what may be accepted and what should be rejected, or it may be made to determine the analysis of the various materials tried out, with a view to determining which materials will give the best results, so that specifications for future orders may be intelligently written. The case of the firm mentioned is only one of many that could be cited to show the need for a works laboratory with a technical trained man in charge and sufficient equipment and help to provide for testing all raw materials that are required to be very close to certain specifications. The time is not far distant when a works laboratory will not be looked upon simply as an advertising point or something to be established when the surplus capital becomes too large, but will be considered just as essential as any production department.

Philadelphia, Pa. ARTHUR L. COLLINS

DRILL JIG FOR GAS-BURNER PIPE

The gas-burner pipe shown at *A* in the illustration is used to heat the shoe of an electrically driven automatic ironing machine. The iron pipe is 50 inches in length and is required to have eighty-six 1/8-inch holes drilled in the side as shown. Previous to the development of the drill jig shown in the lower part of the illustration, these holes were drilled in the following manner: The pipe was clamped to a work-bench, and a prick-punch guide or templet with the required number of holes was set over it. Prick-punch marks were then made in the pipe to locate each of the eighty-six small holes. The next operation was the drilling of the holes. This required considerable time, as the pipe was set in a pair of V-blocks and had to be relocated to bring each hole or prick-punch mark into position for drilling. In order to save time on the operation, the drill jig shown in the lower views was designed



Jig used in drilling Evenly Spaced Holes in Gas-burner Pipe

In using the drill jig, base *B* is clamped to the table of the drill press so that the drill bushing *C* is in accurate alignment with the spindle of the machine. After the jig ation, the drill jig shown in the lower views was designed in the feed-block *D* by means of screw *E*. An end view of feed-block *D* is shown in the upper right-hand corner of the illustration. The end of the pipe opposite block *D* rests on the hardened plates *F*, which act as a V-block.

In performing the drilling operation, the operator keeps his left hand on the feed-lever *G*, while his right hand is used to feed the drill. The pipe is located for drilling the first hole, and after the first hole is drilled and the drill raised from contact with the work, feed-lever *G* is moved to the right until the stop *H* comes in contact with the base of the fixture. This motion moves the feed rack *K* to the

right, causing the dog L to move outward and drop into the next tooth space.

The handle G is then returned to its original position so that the stop J comes in contact with the side of the base opposite stop H. The pipe is now in the correct position for drilling the second hole. This process of relocating and drilling is repeated until all the holes have been drilled. There is a little lost motion when this method of drilling is employed. The writer has seen one of the burner pipes finished in exactly three minutes eight seconds (floor-to-floor time). With the method formerly used, from thirteen to fifteen minutes was required to finish one pipe.

Cicero, Ill. JOHN BORKENHAGEN

CENTER-PUNCH LOCATING BLOCK

Ordinarily a machinist's scale and a pair of dividers are used in laying out tools and jigs when a fine degree of accuracy is not necessary. When greater accuracy is required, the button or disk method is commonly employed. All button or disk methods are necessarily slow, as there is a great deal of checking up between buttons, not to mention the time required in making the first rough lay-out and in drilling and tapping the screw holes for attaching the buttons or disks.

When accuracy is the prime object, time is a secondary consideration; nevertheless, the time consumed in locating buttons or disks enters largely into the cost of the finished product. In order to obtain greater speed in laying out accurate work, the writer designed the combination center-punch and locating block shown in Fig. 1. Those familiar with shop practice know that a center-punch mark can be indicated the same as a button. The usual objection to this method is the difficulty experienced in locating the center-punch marks accurately. The accuracy of all methods based on the location of lines, the crossing points of which are intended to determine the position of the holes, is impaired by the personal element. This element however is eliminated when blocks of the type shown are employed.

The construction of the combination center-punch and locating block is simple, the block proper being made of tool steel, hardened and ground. The hole for the punch is lapped to a gage fit on an accurately ground and lapped punch. The block is put on an arbor and ground true on the four sides and squared up on the bottom side. The round upper part is knurled to give a good grip for the fingers. The punch is of the best grade of tool steel, hardened, ground, and lapped. The point is ground concentric with the body and to an included angle of 60 degrees. The head end is beveled as shown, and is heat-treated or drawn to make it a little softer than the remainder of the punch.

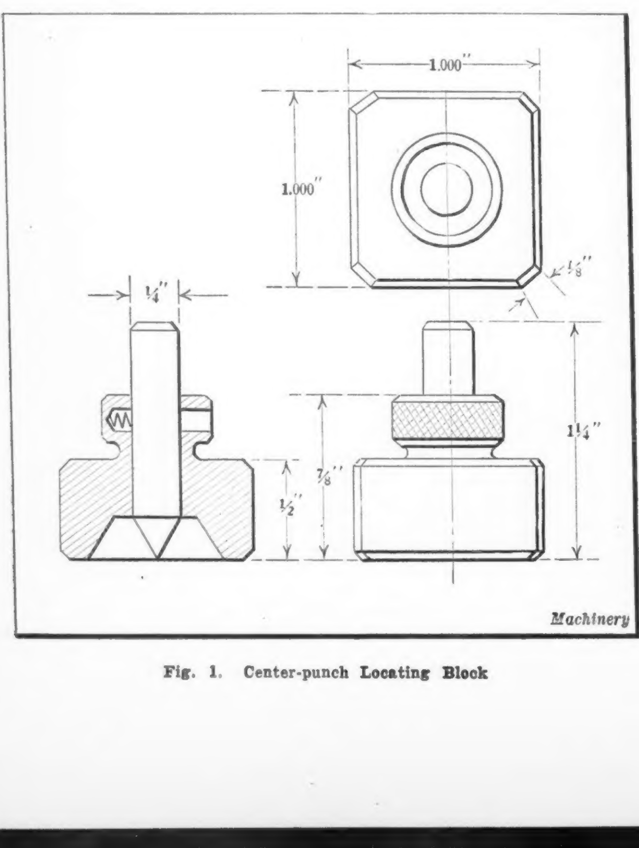


Fig. 1. Center-punch Locating Block

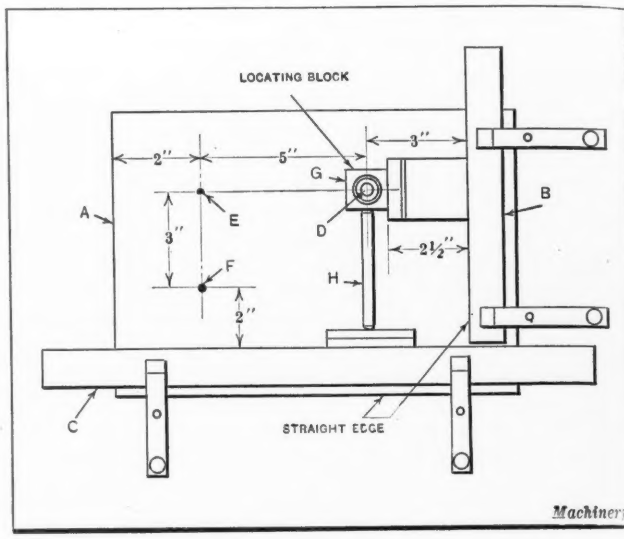


Fig. 2. Method of using Locating Block shown in Fig. 1

The combination punch and block can be employed in various ways. Referring to Fig. 2, A is an accurately surfaced plate on which two straightedges B and C are clamped. The straightedges are carefully located at right angles to each other and serve as gaging surfaces from which to locate prick-punch marks at D, E, and F. In this illustration the locating block and punch are shown at G in position for making the center-punch mark at D. The gage-blocks in contact with the inner surface of the straightedge B have a total thickness of 2½ inches and serve accurately to position the prick-punch mark 3 inches from the locating surface of straightedge B.

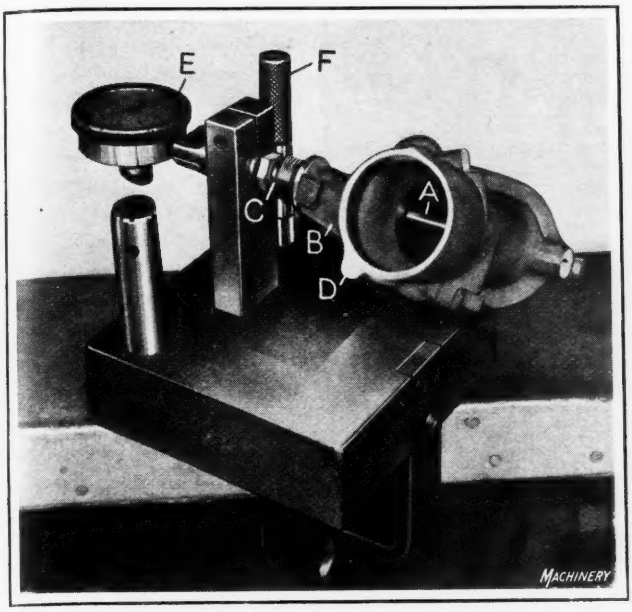
As shown, gage-blocks in combination with rod H locate the center of block G 3 inches above the center F. Centers E and F are located in a similar manner by the use of gage-blocks and rods. In locating the block G, it is necessary that gage-blocks be used on one side in order that the block will be properly squared up or located parallel with the straightedges. For this reason pins such as shown at H can be used only on one side of the punch locating block. When the gage-blocks and the locating block have been set to the proper position, a light pressure is brought to bear against the locating block in order to keep it in contact with the gage-blocks, or with the gage-blocks and rod, as the case may be. A light tap with a rawhide or babbitt hammer will serve to locate the center mark; this can later be enlarged with a punch designed for the purpose, which is equipped with a sleeve that holds the enlarging punch vertical or at right angles to the surface of the work.

Instead of using straightedges as shown in Fig. 2, machinists' squares may sometimes be employed to advantage. Of course when a series of holes are to be located in a straight line, it is only necessary to employ one straightedge and a pin or block which can be clamped to the work to provide a suitable locating surface.

Allentown, Pa. JOE V. ROMIG

INSPECTION GAGE FOR CARBURETOR BODY

A gage used in the inspection of motorcycle carburetor bodies is shown in the accompanying illustration. The carburetor body D to be inspected is placed on the pin A and pushed back until the end of the pin strikes the bottom of the hole. If the depth of the hole is correct, the end of boss B will come in contact with a shoulder on the movable member C of the gage at the same time that pin A comes



Gage used in the Inspection of Carburetor Bodies

in contact with the bottom of the hole. However, if the end of boss *B* comes in contact with the shoulder on part *C* before the end of pin *A* reaches the bottom of the hole, the shouldered member of the gage will be moved outward. As member *C* is connected with the contact point of dial indicator *E*, the excess depth of the hole will be shown by the indicator. If this over-depth is greater than the tolerance allowed (about 0.002 inch), the castings are rejected.

This gage is also used to test the location of the large bored hole in relation to the nozzle hole in boss *B*. This test is made with the plug *F*, which has a "Go" and a "Not Go" diameter. The carburetor body remains in the same position on pin *A* during this test. Pin *A* is, of course, a good fit in the hole in boss *B*. Plug *F* is slid into the opening between the side of pin *A* and the side of the large bored hole in the casting. If the plug enters on both sides of the pin the nozzle hole is central with the large bored hole, or in other words the axis of the nozzle hole is on a radial line that passes through the center of the large bored hole. When a carburetor body has passed this inspection, it can be relied upon to function properly and cause no delay in the assembly room.

Providence, R. I. ROBERT MAWSON

RULES VERSUS JUDGMENT

One of the serious errors of management in many shops is that rules are permitted to take precedence over judgment, and that statements of facts applying in one case are assumed to apply in every similar case, without any further consideration of the contributing factors.

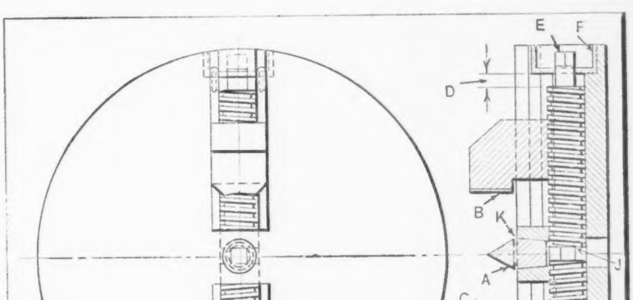
Just because a machine has certain good points, and therefore is the best for the kind of work done in the Smith shop, it does not necessarily follow that it is the best machine for Robinson, who is doing the same kind of work as Smith but under different conditions. Some years ago, a new manager took over a shop making a special machine that would produce a certain article under certain conditions in large quantities. The machine operated successfully when the pieces worked upon were of such shape that they could be put into a rotating chuck without stopping it. The product did not need to run exactly true, nor to be of an exact diameter after finishing. Under these conditions, the machine produced from four to eight times as much as a standard machine tool could have done. It was sold with such a guarantee, and had a record for actual performance, because the former manager picked only those jobs to which the conditions mentioned applied.

The new manager was of the single-track mind, and reasoned that the machine, just because it would accomplish certain results on certain products, must necessarily accomplish these results on all apparently similar articles. The first job that he undertook to handle was one that the former manager had refused, because the work could be done much more cheaply in a small lathe with a two-jaw chuck, for which purpose it did not need to be trued up (as it would have to be for the special machine). The machine was sold, but it was returned because it did not live up to the guarantee, and then the new manager became so discouraged that he decided that this special machine was really valueless, and he sidetracked it. The shop is now principally engaged in jobbing and repair work, when it could have had a profitable regular line of machine building. C. W. LEE

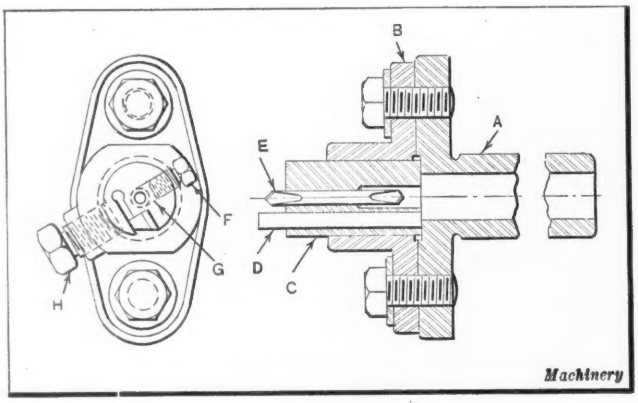
TWO-JAW CHUCK WITH REMOVABLE CENTER

A two-jaw chuck provided with a removable center *A* is here illustrated. The chuck jaws *B* and *C* serve as a means of driving the work when it is mounted on centers and thus take the place of a dog, such as is ordinarily employed with a lathe faceplate. The jaws have the advantage that they can be tightened on rough pieces of work for which a regular lathe dog could not be used. No distortion or misalignment is caused when the work is held on centers, because the jaws are permitted to float in their slots with respect to the chuck body.

It will be noted that there is a clearance *D* between the ends of the threaded part of the chuck-jaw adjusting screw *E* and the screw-retaining cups *F*. This clearance allows the screw to move or float in its bearing in either direction. Thus each jaw has an equal bearing pressure on the work while it is located on center *A*. For example, let it be required to turn down a rod that has a rough surface at the end. The rod is center-drilled, one end being placed on the tailstock center and the other end on center *A*. The jaws are then advanced to the work. Let it now be assumed that the surface of the work is very uneven and that one jaw comes in contact with the work before the other. The jaw in contact with the work then acts as a nut and causes the screw *E* to move away from the stationary jaw. As the screw is revolved, the other jaw is brought into contact with



General-purpose Chuck provided with Means for holding Work on Centers



Combination Centering and Recessing Tool

the work, and the endwise movement of the screw stops. The continued tightening of the screw, however, causes the jaws to grip the work firmly. If it is desired to use the chuck for work that is not to be held between centers, a plug *G* is inserted in place of center *A*, to prevent the screw from floating. The projection *H* on plug *G* rests in the grooved section *J* of screw *E*. Recesses *K* cut in both the plug *G* and the center *A* provide a means of removing these members from the chuck. This chuck is not used on any special job, but is employed for general work in a railway shop.

Hannibal, Mo. E. S. BROWN

CENTERING AND RECESSING TOOL FOR AUTOMATIC SCREW MACHINE

When an automatic screw machine is being tooled up for the production of pieces requiring a number of operations, such as centering, drilling, reaming, recessing, turning, etc., it is often found necessary to design a special tool-holder. Such an occasion arose when a No. 0 B. & S. automatic screw machine was being tooled up for machining a certain piece requiring the use of seven separate tools. As provision was made for holding only six tools in the indexing head of the turret, it was necessary to design a special tool-holder that would permit two of the tools to be held in one turret position, in order to make it possible to perform all the operations in one set-up.

In this particular case, it was decided to combine the operations of centering and recessing. The holder designed to accommodate the centering and recessing tools is shown in the accompanying illustration. It will be noted that the holder is very compact, and that provision is made for adjusting either of the tools without interfering with the setting of the other. For instance, if it is necessary to adjust the centering tool *E*, the screw *F*, which bears against the clamping pad *G*, is loosened and the centering tool *E* is adjusted, after which screw *F* is tightened again without disturbing the recessing tool *D*. In case the recessing tool is to be adjusted, the large clamping screw *H* is loosened, the recessing tool adjusted, and the screw *H* again tightened. It can be readily seen that by this means the adjustment of the centering and recessing tools can be easily and quickly accomplished.

Referring to the construction of the holder, part *A* is a standard floating type of holder, such as is regularly used on the No. 0 B. & S. automatic screw machine. It is made of machine steel and is pack-hardened. Part *C*, which holds the recessing and centering tools is made of tool steel and is hardened. This part is made a drive fit in the hole in part *B*. The hardened and ground tool-steel recessing cutter *D* is made a snug sliding fit in part *C*. The centering tool *E*, also made of tool steel, is hardened and machined to a snug sliding fit in part *C*. The clamping pad *G* is made of machine steel, and is rounded out on one side to fit the cylindrical surface of the centering tool.

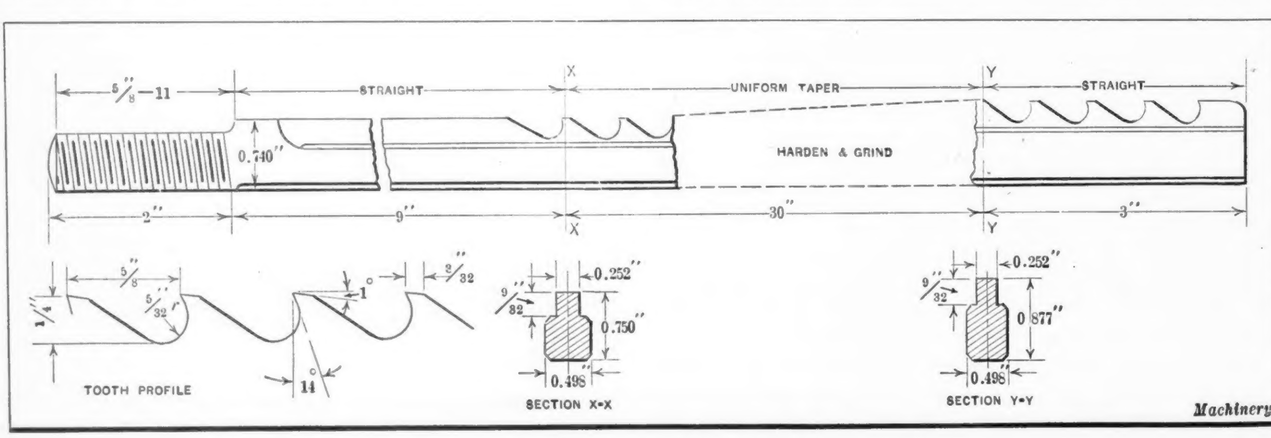
Frankford, Pa. I. BERNARD BLACK

BROACH FOR KEYSEATING HUB

It is not an easy matter to design a broach that will stand up well and produce accurate clean-cut keyseats in hubs such as are used on Ford truck wheels. These hubs are made from steel forgings of an exceedingly tough nature. The hole in the hub is tapered and the length of the keyseat cut in the tapered hole is 4 3/8 inches. Quite extensive experiments were made to determine the design of broach best adapted for this work. The design finally evolved is illustrated herewith. The chief advantage of this broach is that it can be reground on the top of its teeth when it becomes dull. This method of sharpening has proved to be economical with respect to tool life, and can be readily used in sharpening broaches of various types at a comparatively small expense.

It was found in practice that the front rake of the broach teeth should be from 12 to 14 degrees, and that the radius at the bottom of the teeth should be about two-thirds the tooth depth. The chip formed will then curl freely, so that a minimum amount of power will be required to pull the broach through the work. The top clearance should extend to within 1/64 inch of the cutting edge, leaving a land just visible to the eye. Too much land at this point will cause the tool to drag through the work and also provide surface on which particles of the work or chips can "freeze," which not only results in scoring the work but also has a detrimental effect on the teeth. No chip-breaking device is used on the broach shown, as the width of the chip taken is not sufficient to require this. If the width of the chip taken by a broach is greater than 3/8 inch, the teeth should be stagger-nicked on the tapered section. The corners should in no case be beveled off simply for the purpose of breaking up chips. Regrinding on the top of the teeth changes the size or height of the bar, but this change is easily compensated for by introducing a shim of the proper thickness.

New London, Conn. GEORGE E. HODGES

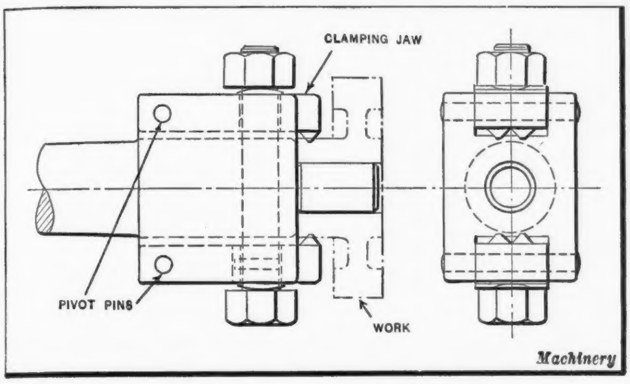


Broach designed to cut Keyway in Hub of Motor Truck Wheel

Shop and Drafting-room Kinks

STUB ARBOR FOR LATHE

A stub arbor of the design here illustrated has been used successfully in turning small gear blanks on a Porter-Cable lathe. The arbor is inexpensive to make and is very durable; it also has great driving power and is quick-acting. The work for which it was originally designed is shown



Stub Arbor used in turning Gear Blanks

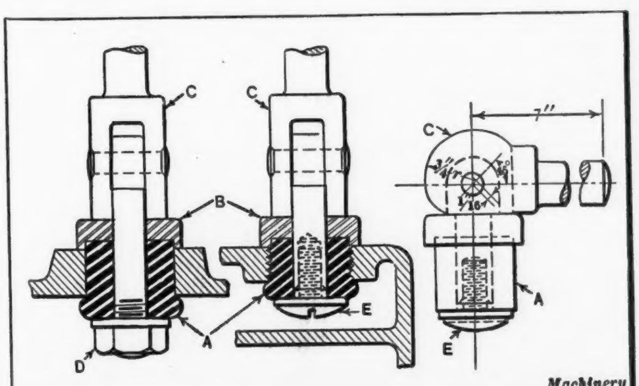
by the dot-and-dash lines; the operations on the part are turning the outside diameter, and finishing the front face. The hole in the work is drilled and reamed and the hub faced in a previous operation.

The stub arbor was found to be an improvement over the expanding shell types, as well as the types provided with C-washers, especially for machining work of the kind shown. The construction of the arbor is clearly shown in the illustration. The writer's experience has been that it is best to avoid the use of expanding shell arbors whenever possible. For work having extremely small holes, expanding arbors are, of course, out of the question, and arbors requiring the use of C-washers do not permit the front face to be finished.

Eastwood, N. Y. Elmer C. Cooley

TESTING CYLINDER WATER CHAMBERS FOR LEAKAGE

In testing cylinder water chambers for leakage, it is necessary to plug up carefully all holes leading to the chamber. As a water pressure of 80 pounds per square inch is often used in testing, an efficient type of plug must be employed.



Plugs used in sealing up Cylinder Chamber for Hydraulic Test

It has been the general practice in the past to use a fixture designed to permit rubber pads or plugs to be clamped to the cylinder over the holes by means of hook-bolts, straps. etc., but this method has proved rather slow.

Automobile engine manufacturers and others who are still using the old method may increase their production by using plugs of the type shown in the accompanying illustration. The plugs *A* are made of medium hard rubber, and are a snug sliding fit in the cored, threaded, or machined holes in the cylinder castings. The rubber plugs are clamped by the action of cam *C* between collar *B* and either a nut *D* or screw head *E*, as the case may be. The nut *D* and the screw *E* should be made of brass, as iron will rust quickly. The cams should have a rise of about 0.001 inch per degree. The plugs, when clamped in either a plain or threaded hole, as shown in the views to the left in the illustration, will not be blown out by any pressure under 100 pounds per square inch.

East Cleveland, Ohio A. G. Merlin

LINING UP CONE PULLEYS

The following method of lining up cone pulleys may be of interest to Machinery's readers. Difficulty is sometimes experienced in lining up cone pulleys so that the belt will run in the correct position on the pulleys; this position is shown by the full lines in the accompanying illustration. The writer has found by experience that very few millwrights and others who have to do with the installation of belt drives are aware of the fact that each of the inside faces *A* and *B* of the cones should form an angle of 90 degrees with a line connecting the two corresponding points *C* and *D*. If this condition does not exist, the belt will tend to climb to the larger ends of the cones. This causes undue stretching of the belt and greater wear on the bearings. The dotted lines show the incorrect location of the pulleys and the resulting incorrect position assumed by the belt under these conditions.

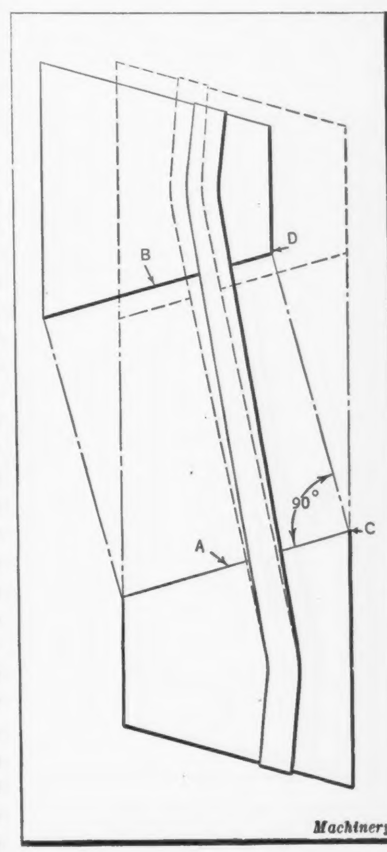


Diagram showing Correct Location of Pulleys in Full Lines

Fitchburg, Mass. J. E. Fenno

A LUBRICANT FOR THREAD CUTTING

Considerable difficulty was experienced in preventing the tool from "hogging in" when coarse-pitch threads (six to ten threads per inch) were being cut on tough carbon steel. After experimenting with a variety of cutting oils and lubricants in an effort to overcome this difficulty, it was found that the best results were obtained with a mixture of turpentine and white lead. Elam Whitney

Questions and Answers

ERICHSEN VALUE

C. D. R.—What is the meaning of the term "Erichsen value" as applied to sheet metal?

A.—The Erichsen value is a factor used to indicate the workability of sheet metal. The test is conducted by supporting the sheet on a circular ring and deforming it at the center of the ring by using a spherical shaped tool. The depth of the impression or cup, in millimeters, required to obtain fracture is the Erichsen value of the metal. Erichsen standard values of sheet metals are furnished by some manufacturers for various sheet thicknesses.

CASEHARDENING WITH CYANIDE BATH

J. C. H.—Is it practicable to use a cyanide bath for casehardening when a deep case is required? If not, what are the difficulties?

A.—Cyanide baths are often used for slight or "superficial" hardening when a very thin but hard skin, only a few thousandths inch deep, is desired. If the work is left in the bath for, say, thirty minutes, the depth of the carburized part will be increased considerably; but the best results are obtained by heating for about fifteen minutes or even less, at temperatures just above the critical range. Heating for much longer periods tends to produce a skin or case which, after quenching, is too brittle and may chip off, especially if the part is subjected to shocks.

U. S. STANDARD THREAD

R. V. S.—What number of threads to the inch is considered standard for a 3/16-inch U. S. standard thread? Practically all screw-makers consider 24 threads as being standard, whereas the tap and die manufacturers list taps and dies having 32 threads per inch as standard.

A.—The standard number of threads for a 3/16-inch U. S. standard screw is 32. The U. S. standard thread was originated by William Sellers, and the following formula was used for determining the pitch:

$$p = 0.24 \sqrt{D + 0.625} - 0.175$$

In this formula, p equals the pitch of the thread and D the outside diameter. In 1882, George M. Bond proposed changing the coefficient 0.24 to 0.23 for diameters below ¼ inch. If this modified formula is applied to the 3/16-inch size, a pitch will be obtained corresponding approximately to 32 threads per inch.

AMOUNT OF CARBON IN TOOL STEEL

J. M.—What percentage of carbon must steel contain in order to be tool steel? What percentage of carbon is necessary to cause hardening, when steel heated to cherry red is suddenly cooled?

A.—There are three general grades of steel, namely, low carbon or mild steel containing up to about 0.25 or 0.30 per cent carbon; medium steel containing somewhere between 0.30 and about 0.60 per cent carbon; and high-carbon or tool steel containing from approximately 0.65 to 1.50 per cent carbon, depending upon the intended use of the steel. As the carbon content is increased up to a certain maximum limit, the hardness of the steel increases when it is heated to the proper temperature and suddenly cooled. There is, however, no definite dividing line between the three general classes of steel referred to. When steel having a medium carbon content is heated and quenched, it becomes perceptibly harder, but is not hard enough for cutting tools, although if a steel containing, say, 0.65 per cent carbon is hard enough for some tool like a drop-hammer die, it might be classed as a tool steel, but it would not harden sufficiently to be used for making tools for cutting steel.

LUBRICANTS FOR DRAWING BRASS

H. B. S.—What lubricant is generally recommended for use in connection with drawing operations on brass and copper parts?

A.—This question was submitted to several manufacturers of sheet-metal products, and summaries of their replies follow, each paragraph containing the information secured from a different company:

1. For drawing operations on brass, copper, etc., we have used soap for many years. Ivory soap chips mixed with water and kept warm have proved very successful. The quantity of soap used depends largely upon the thickness of the metal and the severity of the operation.

2. The lubricant used for drawing brass shells, such as cartridge shells, consists of a solution of soap dissolved in water, the consistency being changed to suit requirements. For heavy shells the solution should be thick—almost like gelatine—and for smaller shells, very thin, so that it will run through the feed-pipes without clogging. In the first cupping operation, oil, known under the trade name of "cupping oil" is preferred, as it has more body than the soap solution, and therefore has a better lubricating effect during the cupping operation, which is a heavy one, displacing considerable metal.

3. From experience we find the best lubricant for brass and copper consists of hard soap dissolved in equal parts of warm water and pure lard oil.

SHOULD AN INVENTOR WRITE HIS PATENT SPECIFICATION?

E. H. K.—I have an invention that I believe to be meritorious. Friends have advised me to make application for letters-patent and say that I can frame my own application and conduct it through the Patent Office. Will you give me your advice in this matter?

ANSWERED BY GLENN B. HARRIS, YONKERS, N. Y.

If you have an invention that seems to possess merit in the judgment of others and you have confidence in their opinions, it is advisable for you to seek a reliable attorney who specializes solely in practice before the Patent Office and the courts in patent matters. A patent specification is an extremely technical instrument, requiring in its preparation, skill of a particularly exacting character, which is acquired only by years of experience and a general knowledge of mechanics and the arts and sciences. In most instances where patent applications are prepared by the inventor, or one not skilled in this particular line, the specifications do not conform to the rules of the Patent Office, fail to describe the invention adequately, and are generally informal in many ways. Furthermore, the claims that constitute the fundamental and essential features of a patent are usually not properly drawn and fail to give the inventor the full protection to which he is entitled. A patent is property, and in many instances extremely valuable; therefore as much care should be exercised in its proper framing and prosecution through the Patent Office as would be given an important case in litigation before a court.

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, March 14

THE improvement in the metal-working industries noticed during January has been maintained in February, and the machine tool industry is sharing in the general movement. Roughly, it may be said that conditions in the machine tool industry are 50 per cent better than at the beginning of the year. The improvement appears to be general, though turret lathes, screw machines, and radial drilling machines are particularly noticeable among the new orders; power presses are also in demand, which is attributable to the rapidly increasing use of hollow ware articles.

Conditions in the Machine Tool Industry

It is gratifying to note that general-purpose machine tools are selling more freely, and in the Birmingham and Manchester districts some manufacturers of such tools are working at 70 per cent of capacity. One well-known maker, within the last two months, has received orders for over £50,000 (about $235,000) worth of machine tools, including lathes, planers, and boring mills.

About half the present activity in the machine tool shops is due to overseas trade, the railway shops in India being the largest individual buyers at the moment. The home trade is divided; railway shops are coming to the fore, particularly for boring mills and lathes, and textile machinery makers are buying quite freely. The electrical trades at present are mainly interested in the heavier machine tools. Heavy grinding machines are in increasing demand, owing to their application to Diesel and other engine manufacture.

Prices of machine tools still reflect the period of slackness, and, generally, it cannot be said that makers are getting returns that are very remunerative. Present prices average 60 to 80 per cent above pre-war figures, and as business continues to improve there is no doubt that these figures will creep upward.

Small tool makers are experiencing much better business, particularly twist drill and hacksaw makers. File manufacturers are busy, but in this trade the underselling policy adopted by some concerns is ruinous to stable conditions. The majority of the makers now, however, have agreed to a schedule of minimum prices, and this move has relieved the situation to some extent.

There is a growing need to standardize hacksaw sizes and details. At present, dealers and manufacturers have to carry about 500 varieties of hacksaws in stock. It is believed that actual necessities would be met by 105 varieties, and if these 105 varieties were standardized, the floating stocks could be proportionately reduced, and the cost of manufacture would be decreased.

Railway and Other Engineering Fields

The home railways as a result of the recent regrouping, will, it is expected, adopt a progressive policy to meet the requirements of the new conditions, and large contracts for cars are likely to be placed immediately. What the exact program is to be with regard to the locomotive shops is not yet known. Some scheme of centralization will doubtless be adopted to eliminate the condition of having works scattered all over the country. Financial conditions are now such, owing to the settlement of the government compensation, as to render possible the purchase of the much-needed tool equipment for manufacturing and repair work.

The railways are being pressed for an immediate further reduction in freight rates, which, if effected, should provide a further stimulus to trade. South America is again inquiring for railway cars, and the contracts placed by India a month ago have been followed by others. Many new constructional schemes have been announced.

Iron and Steel Industries

In the iron and steel industries, the shortage of pig iron is assuming almost the proportions of a famine, and is an outstanding feature of the trade situation. Few of the great producing centers have any iron to sell having contracted for the whole output for a considerable time ahead, and are not desirous of obtaining additional business, as higher prices are considered probable. Relief will be slow as long as the insistent demand for blast-furnace coke from the Continent, due to the position in the Ruhr district, continues. The shortage not only prevents additional furnaces being blown in, but is also causing a limitation of output from those actually working. Prices have already gone up with a bound. The ruling price for machine tool castings in the Birmingham district varies between 4 and 5 cents per pound.

Steel mills are obtaining a good many orders. In many cases their works are engaged at their fullest capacity, and are booked as far ahead as June. There is, however, not much enthusiasm over the prevailing prices. Under ordinary circumstances business would be fairly profitable, but with taxation as it is, practically all of the profits are absorbed in satisfying government demands.

The Automobile Industry

Some of the manufacturers of the more inexpensive light cars are working extra shifts, and motorcycle makers generally are busy; one well-known firm of motorcycle manufacturers is purchasing additional equipment calculated to increase its output by 50 per cent. Makers of commercial vehicles find orders difficult to obtain. A contributing factor is the continued supply of second-hand trucks that have been purchased by dealers from government stocks.

Overseas Trade in Machine Tools

The foreign trade in machine tools during January showed a decided improvement over December, and viewed as a whole the total returns since last June indicate a definitely increasing trade. In January the exports, as compared with the preceding month, rose from 955 to 1337 tons, and in total value from £112,090 to £157,477. This is a substantial advance on the month, and on the monthly average of 1,014 tons for 1922. The export of tools and milling cutters also rose from £30,181 to £37,574.

Imports rose slightly from 262 to 276 tons. The value per ton of exports rose from £117 to £118, while that of imports fell from £141 to £123. The national total of imports for January rose by about 4 per cent to £100,000,000; while exports rose fully 6 per cent to £67,000,000.

In every class of machine tools, exports were considerably greater than imports both in tonnage and value. The greatest value per ton was shown by imported grinding machines at £210, while milling machines at £201, showed the highest value per ton among exports. Imported lathes at £86 per ton showed the lowest value, and £81 was the lowest exported value per ton, represented by presses, punching, and shearing machines.

The Machine-building Industries

THE present industrial situation is briefly summed up in the statement that the output of practically all basic products and materials is the largest since the boom period in the early months of 1920, and in some cases exceeds the production at that time. The steel mills are working as close to capacity as they have ever done, and the automobile industry is producing more than ever before at this time of the year. The Department of Commerce finds business confidence again reestablished throughout the country, and the Federal Reserve Bank points out that production in the basic industries, measured by the Federal Reserve Board's index, was 6 per cent higher in January than in December, reaching a volume that has been exceeded only once in the past—in May, 1917.

These statements relating to the basic industries—iron and steel, mining, transportation and textiles—are found to be equally true in many specialized fields in the machine-building industry, as verified by visits during the past month by the editor of MACHINERY to over ninety machine-building plants, manufacturing not only machine tools, small tools and other shop equipment, but many classes of industrial machinery—woodworking machinery, textile machinery, excavating and road machinery, locomotives, steam turbines, electric generators and motors, pumps and pumping engines, gas engines and general power plant equipment, hydraulic turbines, electric furnaces, tube mills, automobiles, and railroad cars. In all these plants there is great activity, most of the shops running to capacity and some having orders on hand—especially in the power plant field—that will not be completed for over a year to come. The farm implement factories, while not running to capacity, are reported to average about 70 per cent of a normal output.

In the general industrial field, equal activity is in evidence. Production in the cotton industry is the highest on record, the woolen industry is very active, and the paper mills are working to capacity, with the price of paper advancing. Contracts awarded in the building industry during February exceeded all previous records for this time of the year. High prices of materials, and wages in the building field out of proportion to wages in other industries, may adversely affect the building boom, and it is believed that later in the season there will be a serious labor shortage in this field. The extraordinary activity in the building field affects a number of metal-working industries, in increasing the demand for bolt and rivet machinery, pipe-cutting machinery, pipe-threading tools, and hardware.

Unusual Demand for Labor and Materials

The obstacles to a continuance of the present rate of production are mainly labor shortage; shortage in, and higher prices for, pig iron and steel; and, in New England and northern New York state, coal shortage. Higher wages seem inevitable in some instances as a result of the labor shortage, and there are already evidences of manufacturers bidding against each other for the available labor supply, a method that has a tendency to raise wages and prices without in any way increasing the available supply of labor. The labor shortage can be met effectively only by an increase in the efficiency of labor, so that higher wages and permanent employment may be insured right along, which, in turn, would lead to increased purchasing power and continued prosperity.

There is also a shortage in railway transportation facilities, but as a great deal of new equipment is being purchased by the roads, and as the short hauls are being more and more effectively taken care of by motor truck transportation, it is likely that transportation difficulties will not seriously hamper the continuation of present industrial activities.

The Machine Tool Industry

The improvement in the general industrial situation has naturally affected the machine tool industry favorably, but owing to the great amount of equipment available in machine shops throughout the country, the point has not yet been reached where much new equipment is required. The business of the machine tool industry averages about 40 per cent of the peak business in the early months of 1920; this is considered by many of the leaders in the industry as equal to two-thirds of a normal business, taking the word "normal" to mean the status of the machine tool industry had it developed up to the present in a uniform manner without the artificial stimulus of the war.

The stocks of machine tools are in many cases sold off or are rapidly being diminished. In the Detroit district, especially the volume of sales has been very satisfactory, some manufacturers having sold more machine tools in this district since January 1 than during the entire past year. The demand is mostly for machines developed specifically for high production in the automobile industry, and some of the makers of high-production milling machines and drilling machines are working practically to capacity. Some shops are now operating ahead of the present demand, accumulating stock in anticipation of higher prices for materials and higher wages.

When standard machines are required, quick deliveries are demanded, and in several cases the manufacturers have lost orders because they were unable to quote early deliveries. On some sizes and types of standard milling machines, one maker now quotes from ten to twelve weeks' delivery. There is a good business in high-power drilling machines, and even a fair export trade in this line. Shops making heavy railroad tools are finding a fair demand for their product, the forging machinery builders are active, and the demand for patternmaking machinery has lately shown a decided increase. The business in disk grinders is said by one manufacturer to exceed the pre-war business. Machine tool prices show a tendency toward further increases.

The Small Tool Industry

In the small tool field, some of the tap manufacturers consider business normal, although their plants are not running to capacity. Others, with less extensive plants, find it necessary to run a full force, and would even employ a small night shift if men were available. Some of the large drill manufacturers operate at 75 to 100 per cent capacity, and at least one of the well-known drill makers employs two shifts. In some instances, the operations are limited only by the difficulty of rapidly building up a new force, since the plants were practically closed down at the lowest point of the depression. Prices of drills, which were entirely too low a year ago to yield any profits whatever, have been increased, and with rising steel prices further increases may be expected. Tap prices, in some instances, have been increased 10 per cent.

There is nothing on the horizon that threatens to lessen this great industrial activity. No signs of impending industrial disturbances can be seen, and there is no likelihood of strikes in any of the basic industries. At the same time, the buying power of the public is constantly on the increase.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

Lees-Bradner Gear-tooth Testing Machine

In the automobile industry and also in other machine-building industries where it is required to produce high-grade gears in large quantities, it is important to have a reliable means of determining the accuracy of the product. A machine that has recently been developed for this purpose by the Lees-Bradner Co., Cleveland, Ohio, provides for checking the accuracy of that portion of the tooth contour that conforms to an involute curve, and for determining the uniformity of spacing of the teeth. This equipment checks to 0.0001 inch, and is intended for use in inspecting the teeth of gears finished by grinding, as well as gears that are not ground after the teeth have been formed.

For testing the accuracy of the involute tooth form, this design of gear-tooth testing machine follows the principle that governs the tracing of an involute curve, namely, the unwinding of a string wrapped around a cylinder. In this machine, there is a disk *A* (see illustration Fig. 2) for testing gears of any given base diameter, the diameter of the disk being equal to the base-circle diameter of the gears that are to be tested with it. The periphery of this disk is accurately ground, and rolling in contact with it, there is a straightedge *B*, which is also ground accurately. The action of the straightedge in rolling on the disk is equivalent to the process of unwrapping a string from a cylinder in order to generate an involute curve.

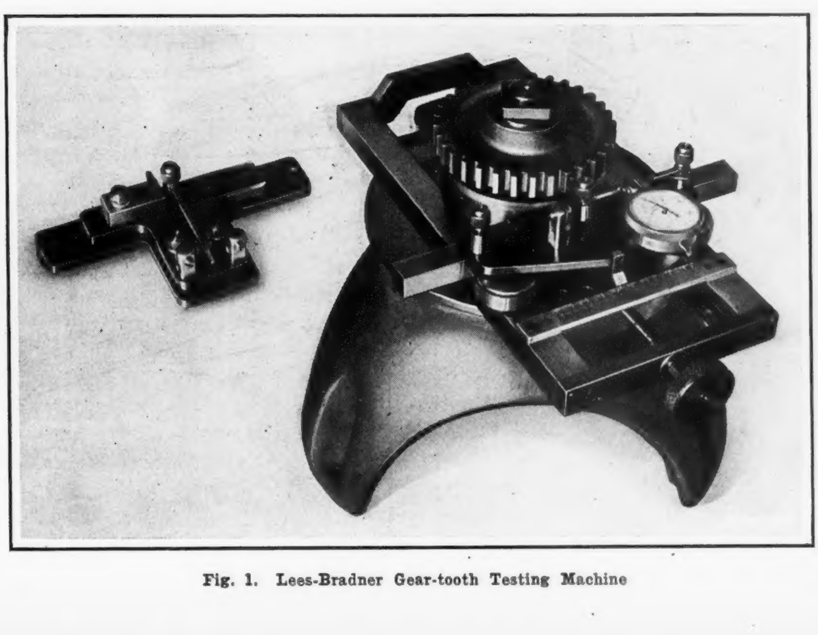


Fig. 1. Lees-Bradner Gear-tooth Testing Machine

Straightedge *B* carries a bracket on which are mounted a contact point *C*, magnifying levers *D*, and a dial indicator *E*. Contact point *C* engages successive teeth of the gear to be tested, as shown in Fig. 3, and by rolling straightedge *B* on disk *A*, Fig. 2, this contact point is caused to travel along the gear tooth from the base circle to the outside edge. As contact point *C* is directly above the position of tangency between the straightedge and the disk, it is apparent that it should generate an involute curve through the rolling action of the straightedge on the disk. But this contact point follows the curve of the tooth and if this does not conform to a true involute curve, movement will be transmitted from contact point *C* through magnifying levers *D* to indicator *E*. The error is shown by the indicator, each line of which represents an error of 0.0002 inch. The

spaces between successive lines are split by dots to indicate errors of 0.0001 inch.

Charting Deviations from the Involute Form

When inaccuracies are discovered in the tooth form of gears produced in machines set up for quantity production, it may be important to locate accurately the position on the tooth where an error occurs. Or, again, it may be required to make some modification of the tooth form, as in cases where it is required to relieve the points of the teeth. For both of these purposes use is made of the graduated scale *F*. On the bracket that carries the indicating mechanism of the machine, there is a graduation mark *G* which is opposite the zero graduation at the center of scale *F* when contact point *C* engages a tooth at the base circle.

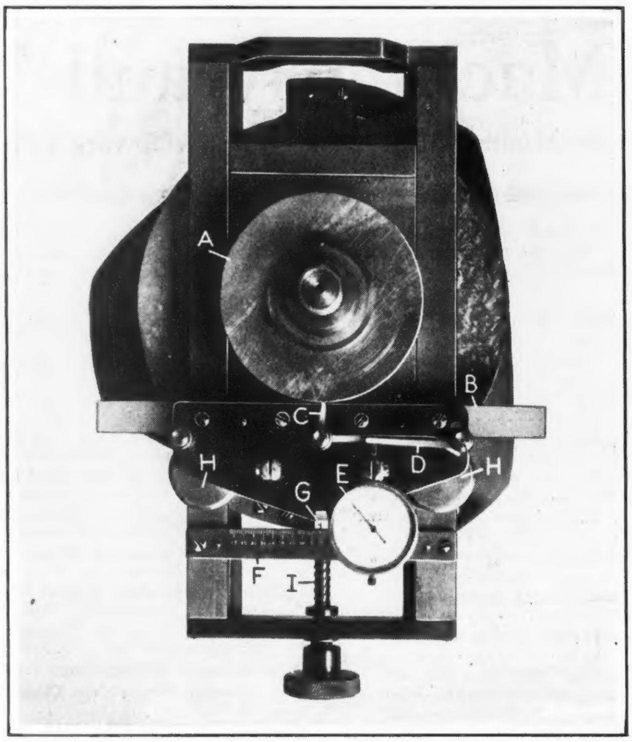


Fig. 2. Gear-tooth Testing Machine with Work removed to show Disk of Base-circle Diameter

In charting a tooth form, an enlarged outline is first drawn, and on this outline circles are laid out concentric to the base circle, and spaced at uniform intervals on the gear tooth. As contact point *C* on the machine slides along the face of a tooth, graduation *G* passes over successive marks on scale *F*, and as each graduation on scale *F* is reached, reference to indicator *E* will show the exact amount of deviation from the true involute form at that particular point on the gear tooth. Hence, the necessary adjustments can be made on the gear-cutting machine to provide for either correcting an inaccuracy discovered in the tooth or obtaining a specified amount of relief at a given point.

The accuracy of the gear-testing equipment is dependent upon the straightedge rolling on the disk without slipping. Slippage is eliminated by applying spring pressure to maintain frictional contact between the two members. This spring pressure is transmitted through two disks *H*, which push against the back of the straightedge. The disks are mounted on ball bearings so that they apply the pressure without the frictional resistance caused by a sliding action. Straightedge *B* is brought into contact with disk *A* when it is changed to suit the gears to be tested, by means of a slide mechanism which provides for bringing disks *H* against the back of the straightedge in the positions required. This slide is manipulated by screw *I*.

Testing the Spacing of Teeth

In testing the accuracy of the tooth spacing on a gear, use is made of a second bracket having contact points. This bracket is shown at the left in Fig. 1, while Fig. 4 shows the machine with this auxiliary mechanism set up ready for use. On the bracket used for supporting the mechanism, there are two contact points *J* and *K* which engage the same sides of two adjacent teeth at points equidistant from the base circle. It does not matter whether the contacts come against the teeth at the base circle or at any other point along the involute curve, as the machine is used as a tolerance gage, not for measuring circular pitch.

Contact point *J* is secured to the bracket on which it is carried, and contact *K* is pivoted to magnifying lever *L* through which motion of the lever is transmitted to the dial indicator *M*. If the tooth spacing is correct, the indicator needle remains at zero when contacts *J* and *K* are brought

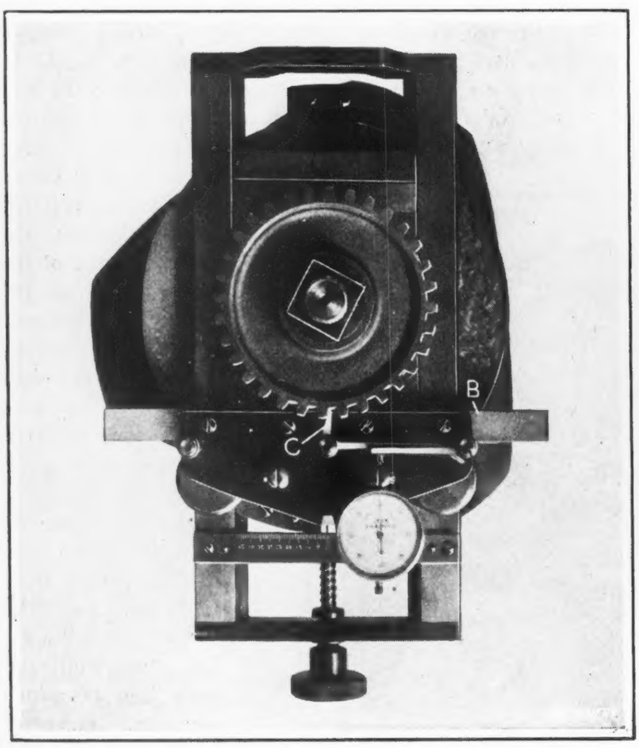


Fig. 3. Testing the Involute Form of Gear Teeth

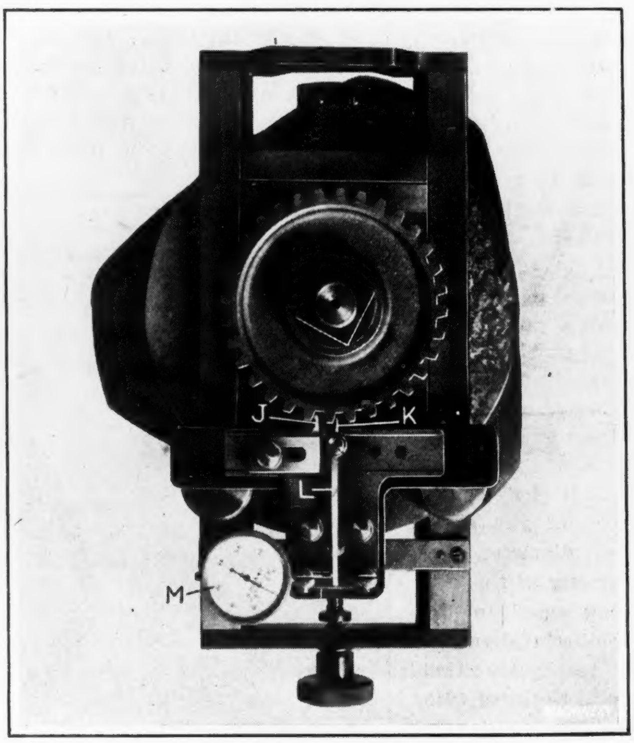
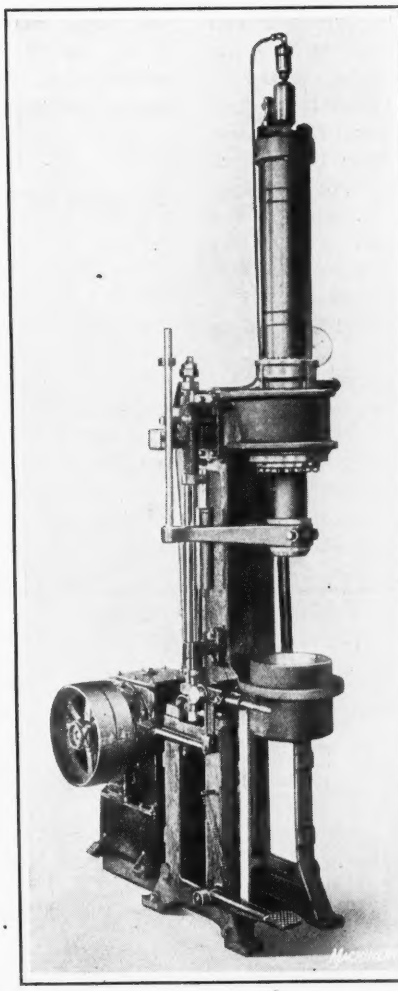


Fig. 4. Determining Accuracy of Spacing of Gear Teeth

into engagement with successive pairs of teeth, but in the event of lack of uniformity, indicator *M* shows the magnitude of error. Thus the indicator gives a definite reading of the actual condition of the gears, in addition to showing whether the error exceeds the tolerance.

OILGEAR BROACHING AND ASSEMBLING PRESS

A vertical gooseneck broaching and assembling press operated hydraulically by an Oilgear variable delivery pump is being manufactured by the Oilgear Co., 64 Twenty-seventh St., Milwaukee, Wis. On this machine the ram speed may be changed either automatically or manually at any point in the stroke. The speed changing, as well as reversing takes place instantly without shock or jar, and without overloading. It is claimed that when the driving unit is an electric motor, the motor never draws more than the rated full-load current from the line, and that when the press is driven from a lineshaft, the line is never slowed down because of any load greater than the normal full load required by the pump. The steady movement of the ram at all speeds makes the press especially adaptable for broaching, and for such assembling as pushing in bushings.


Oilgear Broaching and Assembling Press

The ram movements are controlled automatically by means of adjustable trips and tappets. The ram carries an arm on which is mounted a rod, and on this rod are two adjustable trips. As the ram moves down, the trips release two tappets and permit a control rod to be actuated by a helical spring as each tappet is released. The usual operating cycle is as follows: The operator starts the ram downward by pushing down either the hand- or foot-lever. Depressing the lever to its lowest position causes the ram to advance at its maximum speed. At the point where the ram is about to begin its working stroke, a trip releases one of the tappets and slows down the ram to the pressing speed, and at the end of the working stroke, the second trip operates the second tappet to reverse the ram instantly and return it to the starting position at maximum speed. A collar on the trip-rod engages a stop on the control rod and automatically stops the ram in the starting position, ready for the next cycle. Each new cycle is started by hand.

By changing the positions of the trips, the lengths of the rapid advancing stroke and working stroke, can be regulated to suit the work in hand, and by omitting one trip, the entire stroke can be made a working stroke. No matter what the positions of the trips, the operator can vary the speed of the ram by the manual control lever, or stop it altogether.

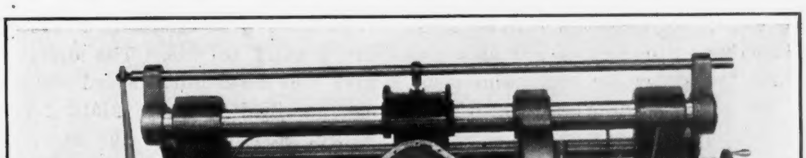
This broaching press is entirely self-contained. The variable delivery pump can be driven from any constant-speed source of power for supplying a flow of oil to the cylinder, the amount depending on the length of the pump stroke, which can be varied from zero to maximum in either direction by means of the control lever. Regulating the flow of oil and thereby the movements of the ram in this manner is said to result in a high efficiency of operation.

This machine is built in four sizes having capacities of 3½, 6, 10, and 14 tons, respectively. Some of the specifications are as follows: Maximum length of stroke, 18 inches; depth of throat, 8 inches; over-all height, 7 feet 2 inches; diameter of hole in table, 7¼ inches; height of table from floor, 35½ inches; speed of pump, 600 revolutions per minute; and motor size recommended, 7½ horsepower. It is said that in an automobile plant on an operation consisting of broaching 1-inch square holes and using two broaches, the production averages 625 pieces per nine-hour day.

SUNDSTRAND DOUBLE-END LATHE

For turning axle shafts, rear axle housings, camshafts, and similar parts that can be turned at both ends simultaneously, the Rockford Tool Co., 2400 Eleventh St., Rockford, Ill., has brought out the Sundstrand double-end lathe here illustrated, which is built in several sizes. The unusually narrow housing enclosing the driving mechanism makes it suited also for turning short pieces, such as four-arm spiders and universal-joint crosses.

It will be seen from the illustration that the construction of this machine is unique in that it has two overhanging arms firmly supported by housings at both ends of the bed. These arms carry two tailstocks and also support the center drive. This arrangement provides a greater adjustment of the tailstocks for various lengths of work, and thus reduces the length of bed from that necessary if the tailstocks were clamped on vees. The tailstocks and center drive are placed close to the front of the machine, making it convenient for the operator to replace work. Chips fall from the carriages into a pan which can be cleaned out from the back.


Sundstrand Double-end Turning Lathe

The center drive is through gearing from the main driving shaft, which extends the entire length of the bed. Pick-off gears connect the main driving shaft to another shaft geared

to the center drive. All these gears are hardened and ground, and those in the center-drive housing run continually in a bath of oil. Power is transmitted through sprockets and chain from the center-drive shaft to the feed-shaft. The latter transmits power through worm-gearing to the front carriages. Feed changes are made by means of the pick-off gears. The two sets of worm-gearing for the front carriages are made right- and left-hand, so that by throwing in the feed, the carriages work toward one another. The worms are constantly submerged in oil and are lifted into engagement with the worm-wheels by means of handles located at the front of the machine. On each worm-wheel shaft there is a large handwheel.

A dog on each carriage trips the feed-levers and automatically disengages the worm and worm-wheel, at the same time disengaging the rear tools. This provides a reliable knock-out, which can be depended on when working to a shoulder or facing to close diameters. The front carriages are mounted directly over the wide front vee of the bed with a view to reducing to a minimum the strain on tools base under the chip pan. Piping extends the full length of the bed to carry coolant to any portion of the work being turned. The 36-inch lathe weighs approximately 5100 pounds, and the 60-inch machine 5500 pounds.

NILES-BEMENT-POND 14-FOOT ENGINE LATHE

The production of steam turbines, turbo-generators, and similar machinery of large size has been responsible for the development of a number of mammoth machine tools. It was to meet the demands of this class of work that the lathe here illustrated was built by the Niles-Bement-Pond Co., 111 Broadway, New York City. The men standing on the machine in the two views are of average height and give an excellent idea of the dimensions. The lathe is rated as having a 14-foot swing, but it actually swings 14 feet 6 inches over the bed, 11 feet 6 inches over the carriage, with a removable section in place, and 12 feet 9 inches

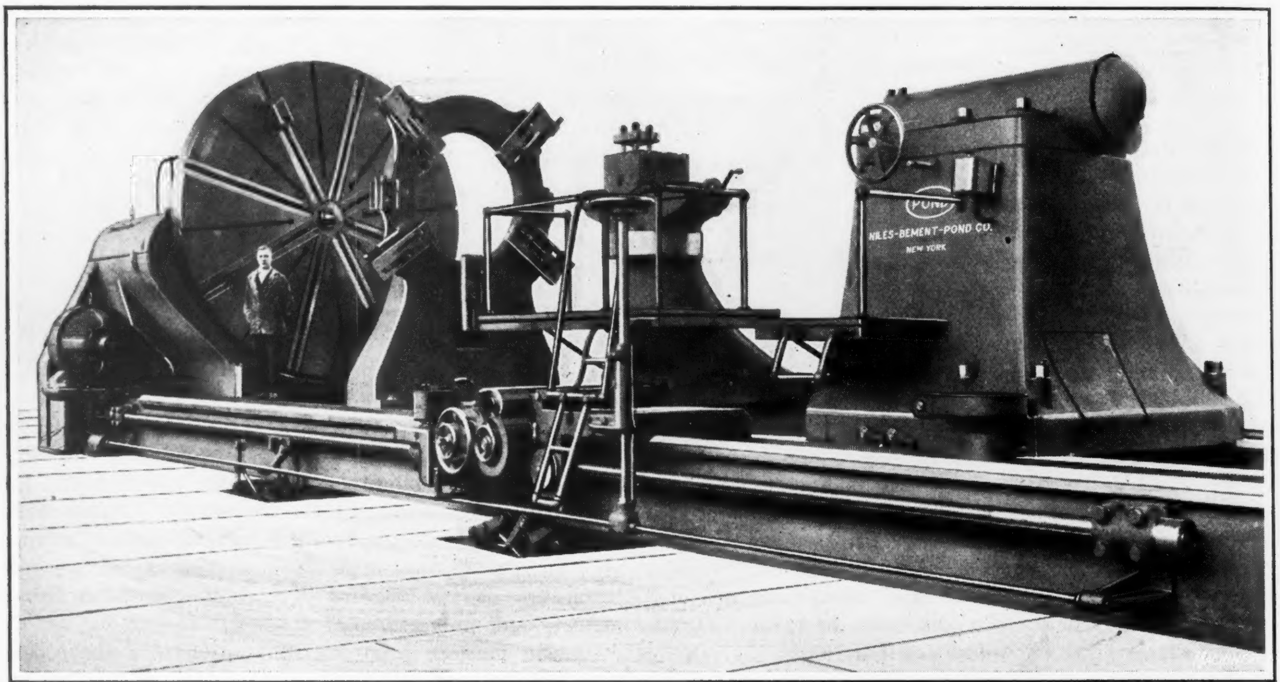


Fig. 1. Niles-Bement-Pond Lathe which swings Work up to 14½ Feet in Diameter and 34 Feet in Length

under the heaviest cuts. Each carriage is 18 inches long and has a full length bearing on an 8-inch face at the front of the bed, and on a 4-inch angular surface on the front of the vee. An angular gib is provided at the bottom of each carriage to take up any wear. Adjustments can be made from the front of the machine. Stop-screws are also provided underneath the front tool-slides for tool adjustment. The width of the front tool-slides permits of several tools being clamped on at one setting.

The rear tool-slides have wide heavy bearings, and are driven by means of a rack and pinion mechanism. They operate simultaneously with the front carriages, and by means of pick-off gears at the back of the machine, independent feeds are obtained to meet the requirements of the work. T-slots are milled in the bed for longitudinal adjustment, thus permitting the rear tools to be placed in different positions for various jobs.

The starting lever for the driving pulley is operated by means of a long rod which extends the full length of the bed. When the machine is arranged for motor drive, the motor is mounted on a bracket below and to the rear of the pulley, a 10-horsepower motor running at 900 revolutions per minute being recommended. An oil pump, driven from the pulley, is regularly furnished, and a tank for the cutting coolant is located directly below the pump in the over the carriage with the section removed. The bed is 50 feet long, allowing a maximum distance between centers of 34 feet.

The headstock is a massive casting, having all its bearings lined with bronze and scraped to fit the shafts, which are ground to size. The driving gears in the headstock give four mechanical speed changes to the spindle. These are obtained by manipulating levers located on the head within easy reach of the operator. The gearing is made accessible for inspection by raising hinged covers. All bearings and gears are lubricated from large sight-feed oil-cups.

The driving motor is mounted on an extension of the bed in front of the head. It is of 50 horsepower capacity and has a speed range of from 500 to 1500 revolutions per minute. In connection with the mechanical speed changes previously mentioned, this gives faceplate speeds ranging from 0.23 to 24 revolutions per minute. The motor may be started, stopped by dynamic brake, reversed or run at any speed within its range, by simply turning a handwheel on the carriage to operate the master switch of an automatic controller through a shaft running along the front of the bed.

The tailstock has a long wide bearing on the bed. In addition to eight clamping bolts, it has pawls which engage ratchets in the bed so as to afford a positive insurance against the tailstock shifting under heavy end thrusts. The

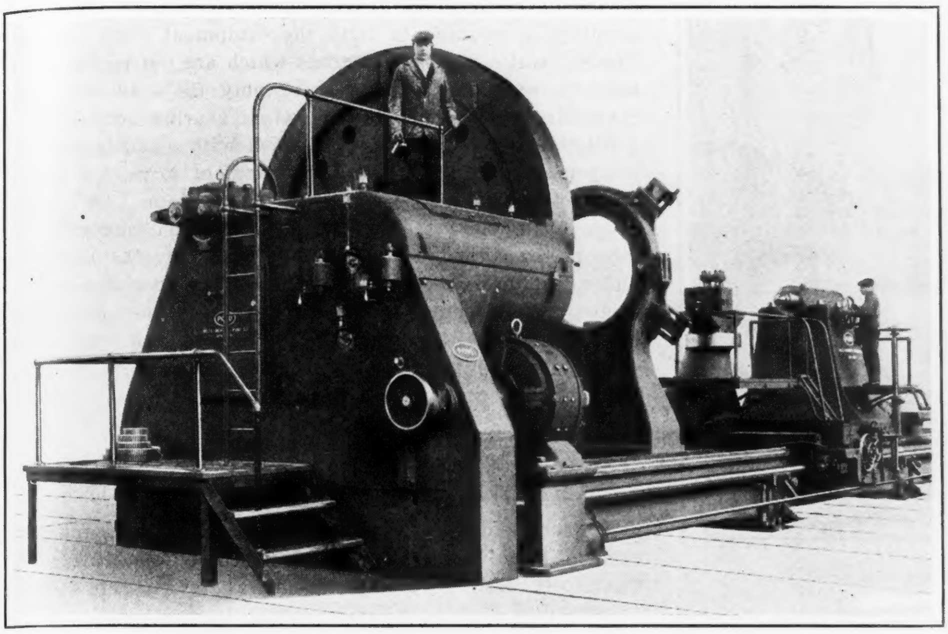


Fig. 2. View of the Heavy Engine Lathe from the Headstock End

upper part of the tailstock carries a large forged steel spindle, which is adjustable by means of a screw and nut operated through a shaft and reduction gearing from a handwheel near the front end of the tailstock. There is a cross adjustment for this part of the tailstock by means of screws enabling angular settings for cutting slight tapers to be made. The upper part is secured to the tailstock base by large bolts which are independent of the base clamping bolts, and therefore the top part may be adjusted crosswise without danger of slipping, though work may be held between the centers. The tailstock has a power traverse along the bed which is obtained through a reversible motor that drives gears engaging the feed rack in the bed.

The tool carriage extends entirely across the bed and has a central depression in which is fitted a removable track. This is the removable section previously referred to. Mounted on the carriage is a long cross-slide which carries a swiveling compound guide for the tool-slide. This permits of turning tapers of considerable length without the use of a separate taper attachment. Lateral, cross and angular feeds by both power and hand are furnished for the tool-slide. An independent motor and controller mounted on the carriage is used for rapidly traversing the carriage in either direction.

The five-jaw steadyrest shown is usually furnished; however, roller steadyrests and C- or back-rests and tool-slide extensions for crankshaft work, can also be supplied. Platforms and ladders are provided on the headstock, carriage, and tailstock for the convenience of the operator in running the machine. The motor-control handwheel on the carriage is mounted on the top of a telescopic shaft which may be lengthened or shortened to permit of revolving it either with the operator standing on the carriage platform or on the floor. The large size of the parts of this machine necessitated four railroad cars for its shipment. The bed is 11 feet wide and the faceplate 12 feet in diameter. The weight of this lathe is about 250,000 pounds.

NIAGARA SPECIAL FORGING PRESS

An interesting development in power presses has been made by the Niagara Machine & Tool Works, 637-697 Northland Ave., Buffalo, N. Y., in equipping its No. 512 straight-sided single-crank press for producing special forgings in large quantities from hot blanks. The machine runs continuously, and produces a finished forging at each stroke of the slide. It is equipped with an automatic dial feed of the ratchet type, as illustrated in Fig. 2; this mechanism consists principally of a circular disk to which intermittent motion is imparted through connections from the crankshaft. There are holes in the circular disk in which are placed interchangeable bushings shaped to receive the hot blanks.

The blanks are placed in the openings of the dial at the rate of eighteen per minute, as the openings approach the front of the press. Each blank is then automatically fed to the die and pressed to shape. It adheres to the punch as this member rises, and the next step is to strip it automatically. As the forging drops, a sweeping member swings out and directs its fall to the rear of the press. The dial has an unusually long period of rest to make possible a deep forming operation and to let the blank remain the necessary amount of time under the pressure of the dies. However, between these working periods, the dial moves rapidly. This intermittent motion is derived from the end of the crankshaft through a crankplate and a slotted lever.

As the operation is performed on hot work, it is necessary to provide a relief to function in case of an overload. A hydraulic release is provided by having the bolster which carries the dial feed and the die mounted on a steel plunger supported by water pressure. Water from ordinary city lines has sufficient pressure to raise the plunger to its maximum height. A check valve is placed in the feed-pipe to prevent a back flow in the feed-line, and a relief valve in the outlet from the cylinder is set to open when the rated

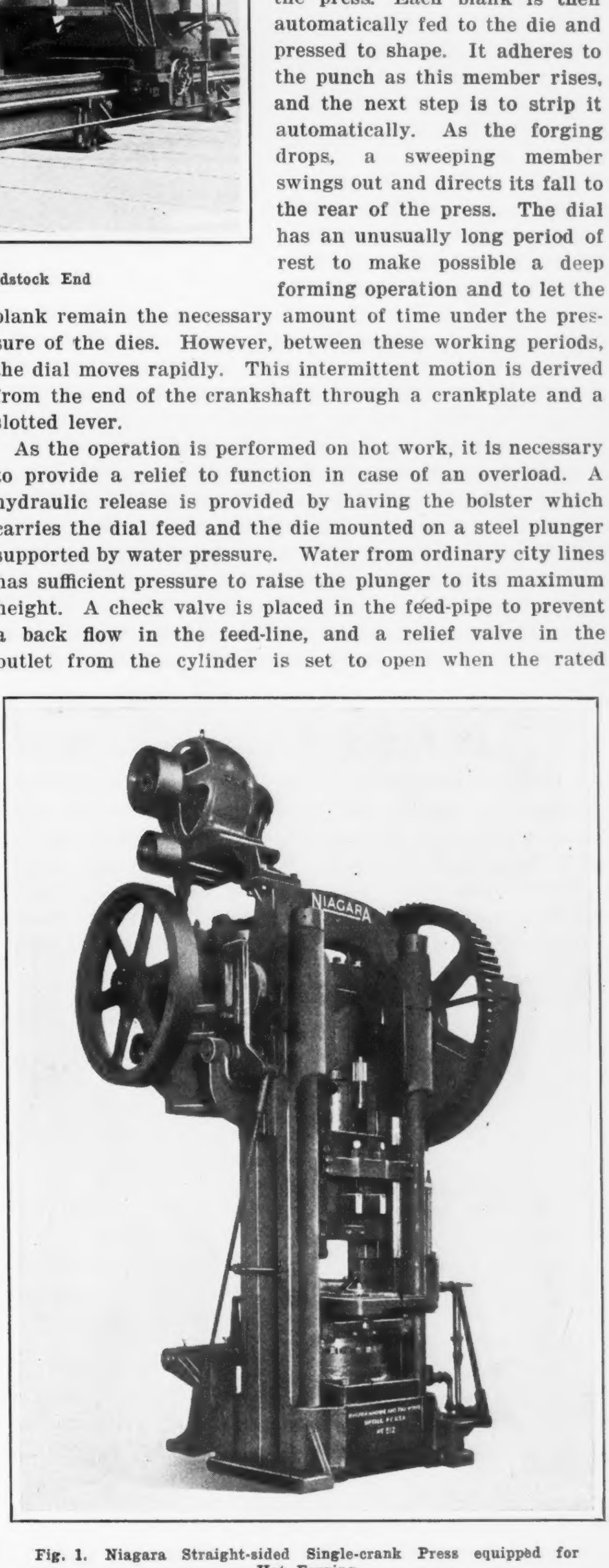


Fig. 1. Niagara Straight-sided Single-crank Press equipped for Hot Forging

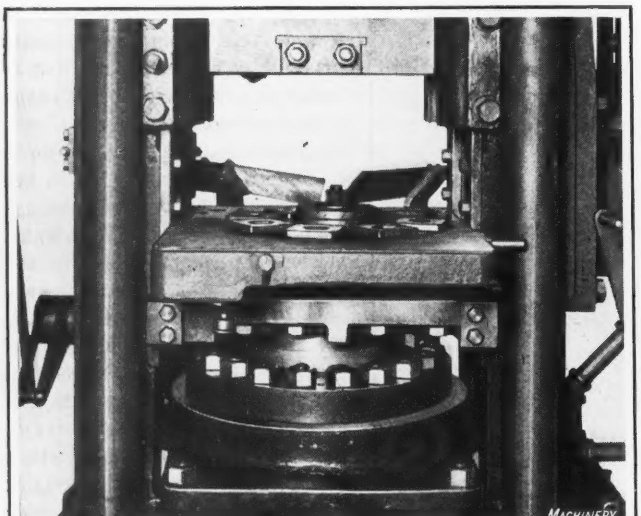


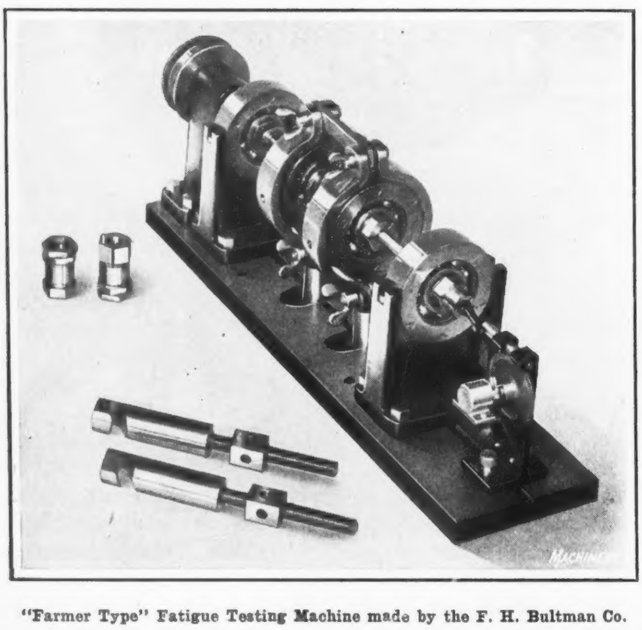
Fig. 2. Automatic Dial Feed provided on Niagara Press

capacity of the press is exceeded. Consequently, should a cold or over-size blank, which would produce an overload, be fed to the die, the bolster, upon opening of the hydraulic relief valve, would be depressed under the pressure of the ram, and protect the machine from overstrain. When this pressure was relieved, the bolster would rise to the correct working height in time for the next stroke of the press.

Three outstanding claims are made as to the suitability of this equipment for use in hot forging work: First, that it gives an output that cannot be equalled by non-automatic devices; second, that its operation is quiet, continuous, and requires a minimum amount of operating skill and attention; and third, that by reason of the protection afforded by the hydraulic release attachment, the press can be limited in size to suit ordinary loads, and need not be made over-size to withstand overloads. The press is double back-geared, and provided with a double-disk friction clutch.

BULTMAN FATIGUE TESTING MACHINE

A machine designed to record the number of alternations of stress that may be applied to a steel specimen before destruction is accomplished, is made by the F. H. Bultman Co., 10271 Berea Road, Cleveland, Ohio. This machine is known as the "Farmer Type" fatigue testing machine. It consists of a baseplate provided with a housing in which are mounted ball bearings that carry the specimen in a horizontal plane,



"Farmer Type" Fatigue Testing Machine made by the F. H. Bultman Co.

and another housing with ball bearings and a shaft on which a pulley is mounted to drive the equipment from a motor. There are also two ball bearings which are put on the specimen to carry the weights that apply the load or stress. Hook-bars are attached to the weight bearing housings.

All the ball bearings are provided with easily adjustable compensating chucks to fit the specimen, so it is a simple matter to mount the specimen in the machine. A bracket at one end of the machine carries a revolution counter which records the number of revolutions made by the specimen under test up to the time of failure. The specimen is connected to this counter by means of a flat notched bar which falls out of position when failure occurs and causes the counter to stop. At the same time the broken specimen swings out of contact with the driving shaft.

TRIPLEX COMBINATION MACHINE

The combination lathe, milling and drilling bench machine developed by the Triplex Machine Tool Corporation, 50 Church St., New York City, which was described in December, 1921, MACHINERY, may now be furnished with a combined floor stand and chip pan as shown. The design is similar to the original model, but the swing over the carriage has been increased from 8 inches to 10 inches. The maximum distance between centers is 14 inches. An important change in the head design is the substitution of S. K. F. radial ball bearings on the change-gear shafts for the bronze bearings formerly used.

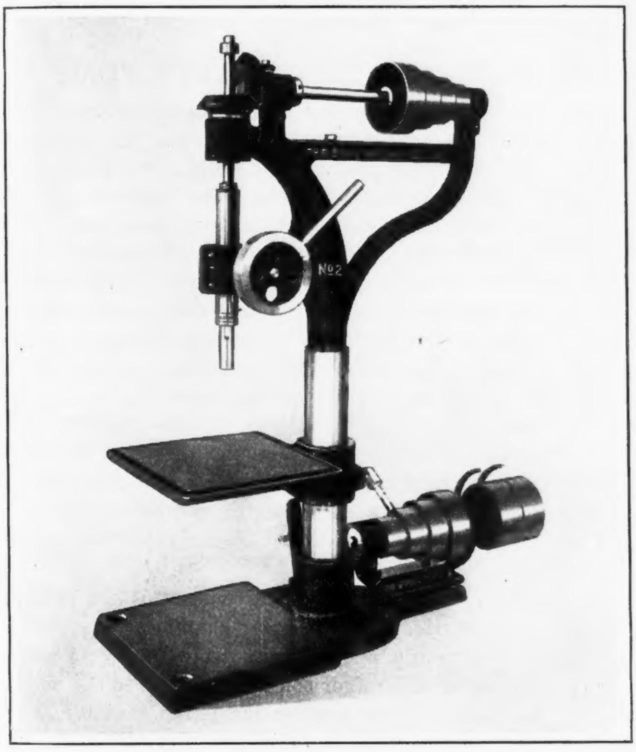
Triplex Combination Machine with Floor Stand and Chip Pan

The maximum spindle speed has been reduced to 1050 revolutions per minute, but the minimum speed of 90 revolutions per minute has been retained. It will be observed that the starting switch is now mounted on the head in a convenient location. A key on the column engages a keyway in the bearing of the bed on the column when the axis of the bed is swung into alignment with the spindle axis, and this insures accurate alignment. The bed is graduated in degrees around its bearing on the column, so that in swiveling the bed for machining bevel surfaces its setting may be determined by referring to the graduations and a scribed line on the column. The opposite end of the bed is graduated to facilitate setting it for turning tapers.

BURKE HEAVY-DUTY BENCH DRILLING MACHINE

A bench drilling machine, with a capacity for drilling holes up to 9/16 inch in diameter, is being built by the Burke Machine Tool Co., 516 Sandusky St., Conneaut, Ohio. The base of this machine is planed so that it may be used as a table when the regular table is turned to one side. All bearings of the machine are made of phosphor-bronze and are provided with deep oil-cellars and wick-feeders. The cone pulleys have four steps of 5, 4¼, 3½, and 2¾ inches diameter, respectively. The countershaft pulleys are 5 inches in diameter, the countershaft being ordinarily driven at a speed of about 800 revolutions per minute.

The driving gears are made of the spiral bevel type, with a view to producing a quiet, smooth-running and powerful machine. Fiber thrust gears are placed under each gear to take the wear. The spindle is ¾ inch in diameter, counterbalanced, and supplied with ball thrust bearings. A fiber collar is also placed under the adjusting nuts of the spindle. A No. 1 Morse taper hole is usually furnished in the spindle nose, but a No. 2 Morse taper can also be provided. The



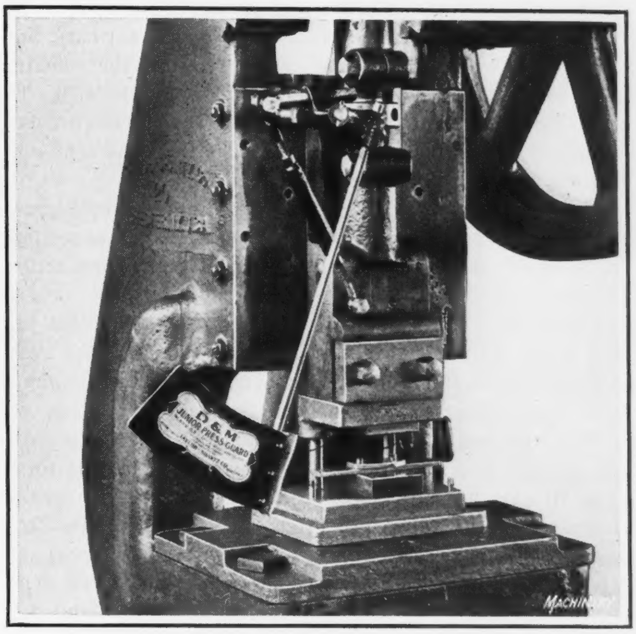
Burke No. 2 Heavy-duty Bench Drilling Machine

bearing for the spindle sleeve is split so as to provide for taking up wear. A stop is attached to the top of the spindle.

A few of the principal dimensions of the machine are as follows: Distance from center of spindle to column, 6¼ inches; dimensions of table exclusive of oil channel, 10 inches square; maximum distance from spindle to base, 18½ inches; maximum distance from spindle to table, 10¾ inches; vertical travel of spindle, 4 inches; and vertical travel of table, 10¾ inches. The machine weighs approximately 170 pounds.

"D. AND M. JUNIOR" PUNCH-PRESS GUARD

A simple punch-press guard consisting of only nine parts is made by the Taylor-Shantz Co., 478-486 St. Paul St., Rochester, N. Y., and sold under the trade name of "D. & M. Junior." As will be seen from the illustration, the guard arm is automatically driven by the ram of the press. It sweeps across the bolster as the ram descends and passes the dies before they are closed. A rubber cushion prevents

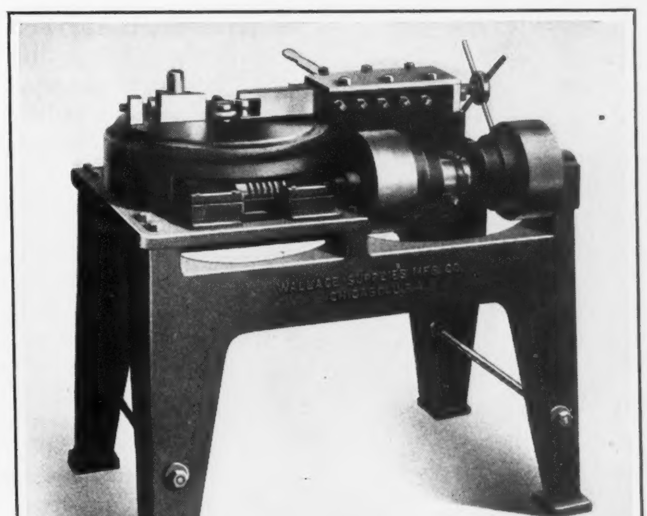


Punch-press Guard made by the Taylor-Shantz Co.

injury to the operator's hand from the guard striking it. The appliance is provided with all the adjustments necessary to adapt it to changes in the die space, in the distance that the guard arm travels, and in the speed at which the arm travels; such adjustments can be made quickly. The only preparation necessary for installing this guard on a press is to drill and tap two holes, no changes being required in the press construction.

WALLACE BENDING MACHINE

For bending round, square, and flat bars, and tee, angle, and channel irons, either hot or cold, the Wallace Supplies Mfg. Co., 412-420 Orleans St., Chicago, Ill., is now making the No. 15 bending machine here illustrated. An adjustable mechanism on the under side of this machine provides for automatically stopping the rotating table at any predetermined point, so that parts can be bent in quantity identically alike as to the number of degrees in the bend. The machine is started by manipulating a hand-lever located on the front side, which is the side opposite that on which the tight and loose pulleys are mounted.



Wallace Bending Machine with Capacity for making Bends of 4 Inches Radius to the Outside of the Work

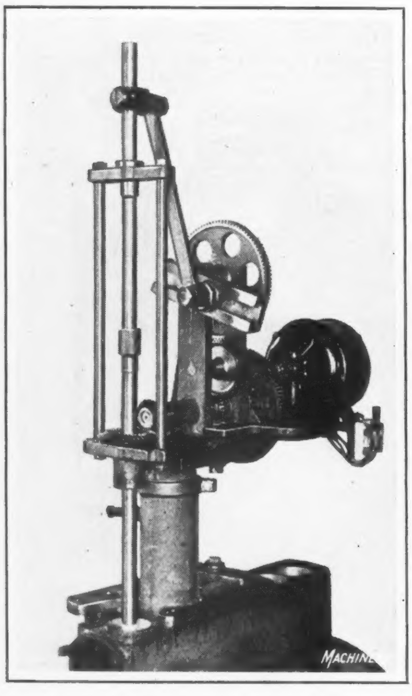
The capacity of this machine in bending cold material is for 1-inch square and round bars, 3/8- by 2-inch flat bars, and 2- by 2- by 1/4-inch angle-irons. In hot bending, the machine has a capacity for 1 1/2-inch square and round bars, 3/4- by 2-inch flat bars, and 2 1/2- by 2 1/2- by 5/16-inch angle-irons. The maximum radius of bend is 4 inches from the center of the circle to the outside edge of the material.

The production varies according to the number of degrees to which the material is bent, and the length, cross-section, and kind of stock. However, a fair average production estimate for ordinary cold-bending of round, square, or flat bars, sidewise, to 180 degrees, is said to be 150 pieces per hour; while in cold-bending flat stock on the edge, the average output is about 100 pieces per hour. The latter estimate would also apply to angle-irons. Bending flat stock on the edge and angle-irons to more than 180 degrees necessitates the use of a split form. The upper part of this form can be lifted after each bend has been completed to permit the removal of the finished part from the machine. For this class of work the average production is about sixty pieces per hour. A three-horsepower motor is recommended for driving the machine. The weight of the machine is about 950 pounds.

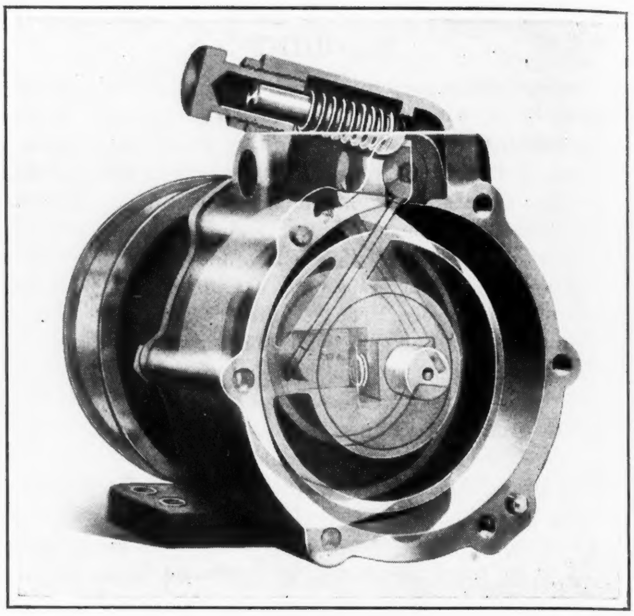
CYLINDER REFINISHING MACHINE

Worn or out-of-round cylinders can be refinished by the honing or lapping process without removing the cylinder block from the automobile, by a new machine developed by Raymond M. Clough, 327 Colony St., Meriden, Conn. For performing the operation, it is only necessary to remove the cylinder head, oil-pan, pistons, and connecting-rods. The machine is then bolted to the top of the cylinder block and readily adjusted centrally with any of the bores, by means of a compound movement derived in the upper section of the machine. The machine has a maximum vertical spindle movement of 12 inches.

The equipment is driven by a 1/2-horsepower alternating-current motor, running at a speed of 1750 revolutions per minute. This speed is reduced to a speed of 112 revolutions per minute by gearing that connects the motor to the spindle. A crank is employed to reciprocate the spindle as it rotates, the crank revolving 49 revolutions per minute or slightly less than once to two revolutions of the spindle. The spindle can also be driven independently of the crank motion by throwing an intermediate gear out of mesh. The hone or lap is attached to the lower end of the spindle by means of a single bolt, and can be easily removed. For convenience in checking the progress of the operation, the upper portion of the machine can be swung out of the way after a clamping screw has been loosened. When the walls of a cylinder have been honed or lapped to the desired dimension, the piston and rings can be run in before removing the machine to the next bore. The weight of this equipment is less than 100 pounds.



Clough Cylinder Lapping Machine



Self-priming Relief-valve Pump manufactured by the Michigan Machine Co.

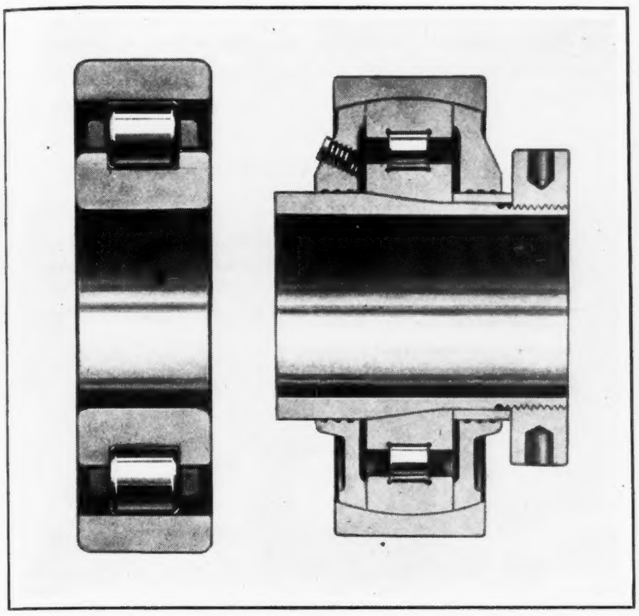
"ROLLWAY" RELIEF-VALVE PUMP

An automatic relief valve has been embodied in the "Rollway" lubricating pump manufactured by the Michigan Machine Co., 85 Porter St., Detroit, Mich., which was described in August, 1919, MACHINERY. The valve can be adjusted to relieve at a given pressure, and transfers all surplus fluid from the discharge line back to the suction line without returning the fluid to the supply tank. This feature saves the expense of independent relief valves and extra piping, and eliminates the stirring up of fine sediment in the supply tank, which may occur with independent relief valves. This pump, known as type R, can be assembled to operate in either clockwise or counter-clockwise direction. It will not pump fluid when revolving in the direction opposite to that for which it is assembled; however it can be run in the reverse direction without damaging the pump, and will start pumping again as soon as the normal direction of rotation is resumed.

The principal pumping mechanism consists of two rollers, which rotate eccentrically in the pump chamber. The entire motion is that of rolling, and so there is practically no wear, such as might occur in another construction due to the movement of the working parts against the pump chamber. The pump is self-priming and will not clog. It is manufactured in various sizes, ranging in capacity from 5 to 160 quarts per minute.

HOFFMAN ROLLER BEARINGS

Rigidly mounted and self-aligning types of roller bearings which in the past have been made by the Hoffman Mfg. Co., Ltd., Chelmsford, England, and sold in European markets, are now being introduced in this country by the Norma Co. of America, Anable Ave., Long Island City, N. Y., which has acquired all the American rights for the bearings. It will be seen from the sectional view at the left in the illustration that in fundamental design, the rigidly mounted type is no radical departure from other standard bearings. The outer race or ring is of plain cylindrical form with a rectangular cross-section. It has a "flat-line" raceway on which the rollers run. The inner race or ring has a channel cross-section, narrow rims being placed on each side of the "flat-line" raceway so as to retain the rollers endwise. The rollers are cylindrical, with a length equal to the diameter. They are held in parallelism with the shaft and with one another by the rims or shoulders of the inner race, which



Hoffman Rigidly Mounted and Self-aligning Roller Bearings

are a distance apart that allows only a slight clearance for the rollers. The roller gage or retainer is of simple construction.

It is obvious that this bearing has no end thrust capacity, and so when end thrust is encountered it is necessary to hold the inner race and the rollers in the correct relation to the outer race by means of a locating device. When the end thrust is small, it may be taken care of by thrust buttons at each end of the shaft, and when the end thrust is large, it may be carried either by auxiliary thrust bearings or by "location bearings" of standard ball type and slightly reduced outside diameter, mounted between two roller bearings.

The same general construction is followed in the Hoffman self-aligning bearing shown at the right in the illustration. The periphery of the outer race of this bearing and of the two dust-and-dirt excluding covers is ground to form a continuous spherical surface which fits a similarly shaped inner surface on the shell or housing. The bearing is thus free to align itself with its opposite members, the dust covers following every movement. This feature permits of boring the covers with but a small running clearance on the clamping sleeve. As a consequence, the lubricant cannot work out, and dust cannot work into the highly finished bearing surfaces. In the example illustrated, the clamping sleeve extends entirely through the dust covers and so the bearing may be mounted without exposing its working parts.

"THOR" PORTABLE ELECTRIC DRILL

A new drill of 3/16-inch capacity has been added to the line of portable electric equipment manufactured by the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill. The armature and commutator in this drill are of the same outside diameter as in the No. 000 drill made by the same company, but the armature core and winding are shorter. The brushes and brush-holders are the same as the ones used in that drill, and so is the stator, except that the latter is made in proportion to the armature. The gear and field cases and the center plate are made from aluminum, the gear-case being so constructed that it can be screwed on the center plate in four positions, so as to give the same number of close-corner spindle positions in drilling.

The upper end of the spindle is supported by a thrust ball bearing, and the armature is pivoted on self-aligning ball bearings. This drill is made in two different styles which are the same except for the handle. Type U. K. B. has an aluminum cover independent of the switch, with the trigger coming through a slot in the cover, while type U. K. C. is equipped with a small grip handle having a push-button switch. A Jacobs chuck is furnished with the standard equipment. The weight of the type U. K. B. is about 3 pounds, 10 ounces, and that of type U. K. C. 4 pounds, 3 ounces.

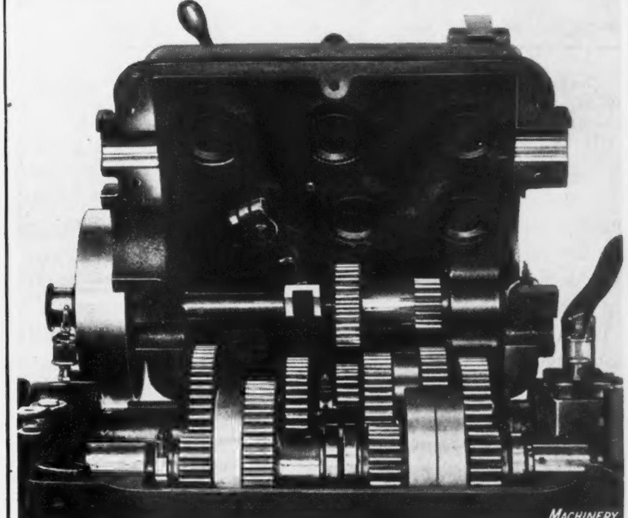
FOSTER ALL-GEARED-HEAD SCREW MACHINES

The Nos. 3, 5 and 7 screw machines made by the Foster Machine Co., Elkhart, Ind., are now equipped with the all-geared head shown in the accompanying illustration. The capacity of the automatic chucks on these machines is for round bar stock up to 1 5/16, 1 13/16, and 2 1/2 inches in diameter, respectively. Except for the geared head, the design of these machines is similar to the friction-head type described in December, 1919, MACHINERY. The machines of the friction-head type are driven through a friction clutch which is mounted on the spindle between a three-step cone pulley and a friction gear in such a way that the spindle can be brought into driving connection either directly with the cone pulley on one side or with back-gears on the other.

Equipped with the all-geared head the No. 3 machine has eight spindle speeds of 29, 43, 64, 98, 147, 225, 337, and 500 revolutions per minute, with the driving pulley running at a speed of 920 revolutions per minute. The pulley is 10 inches in diameter and is driven through a 2-inch belt by a 2-horsepower motor running at 1800 revolutions per minute. The swing over the bed is 14½ inches; over the carriage guides, 13 inches; and over the cut-off slide, 6⅛ inches. The hole through the spindle is 1⅝ inches in diameter, and the thread on the spindle nose is 4 inches in diameter with six threads per inch.

The spindle speeds on the No. 5 machine are 24, 36, 54, 80, 121, 187, 273, and 414 revolutions per minute with a driving pulley speed of 760 revolutions per minute. The driving pulley on this machine is 11 inches in diameter and carries a belt 2½ inches in width. A 3-horsepower motor also running at 1800 revolutions per minute supplies the drive. The swing over the bed is 17½ inches; over the carriage guides, 16 inches; and over the cut-off slide, 8 inches. The hole through the spindle is 2⅛ inches in diameter, and the thread on the spindle nose is 4⅞ inches in diameter with six threads per inch.

The spindle speeds on the No. 7 machine are 20, 30, 45, 67, 102, 150, 227, and 337 revolutions per minute, with a driving pulley speed of 780 revolutions per minute. The driving pulley is 12 inches in diameter and takes a 3-inch

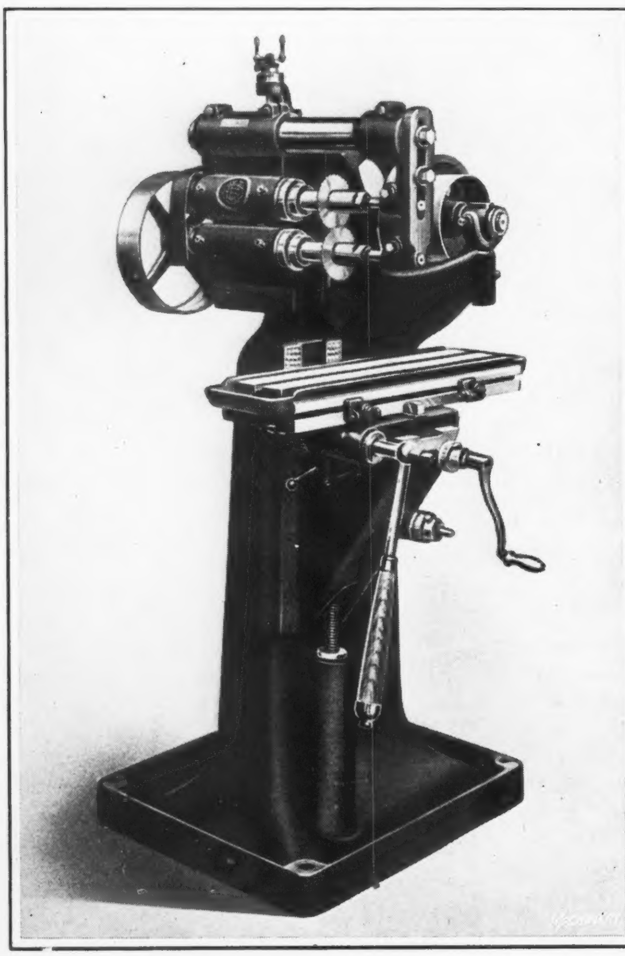


All-geared Head now furnished on Foster Screw Machines

belt. A 5-horsepower motor having a speed of 1800 revolutions per minute is used. The swing over the bed is 20 inches; over the carriage guides, 18½ inches; and over the cut-off slide, 10 inches. The hole through the spindle is 3 inches in diameter, and the thread on the spindle nose is 6⅛ inches in diameter, with six threads per inch.

U. S. DOUBLE-SPINDLE HAND MILLING MACHINE

A double-spindle milling machine of the hand-operated type has been brought out by the United States Machine Tool Co., Richmond St. and McLean Ave., Cincinnati, Ohio. This machine was designed primarily for milling the step slot in automobile piston-rings; however, it can also be used to advantage on other operations, such as milling opposite keyways in small shafts. All feeds are by hand, the same as on the single-spindle milling machine which has been



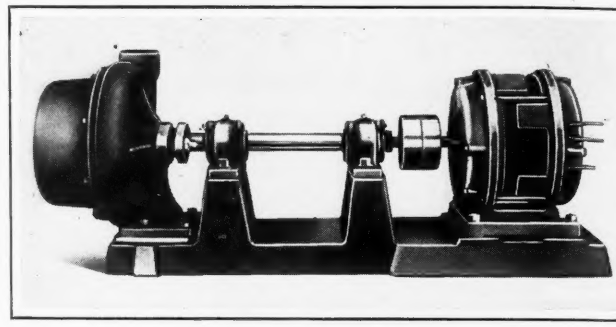
Double-spindle Hand Milling Machine built by the United States Machine Tool Co.

built for years by this firm. There are two arbors on the new machine, one of these running in the right-hand direction and the other in the left-hand direction. Two or more cutters may be mounted on them at one time. The upper spindle is adjustable away from the lower one a distance of 1¼ inches to allow for wear of the cutters. The spindles are special drop-forgings and run in bronze bearings.

The table measures 7 by 23 inches, and has a longitudinal movement of 6 inches when operated by the hand-lever, and 16 inches when operated by the crank. The cross-feed is 5 inches, and the vertical feed 15¾ inches. Micrometer dials are provided on all feeds to permit of making close adjustments. The machine can be furnished with either a three- or a two-step cone pulley and a countershaft of the friction-pulley type, or with a direct motor drive. About two horsepower is required to run the machine. It is claimed that 300 or more piston-rings can be milled per hour on this double-spindle machine, the production depending to some extent on the design of the fixture provided for holding the work.

"FULFLO" MOTOR-DRIVEN PUMP

A seventy-five gallon motor-driven pump has been added to the line of pumps made by the Fulflo Specialties Co., Blanchester, Ohio. This pump is equipped with ball bearings

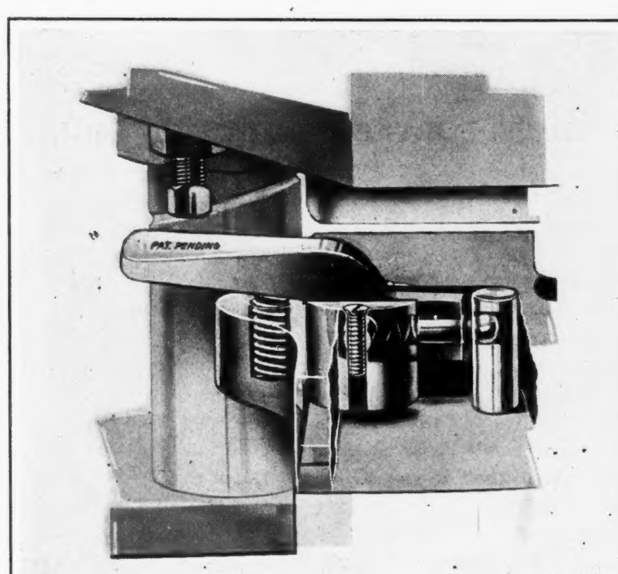


"Fulflo" Motor-driven Self-priming Pump

throughout, and is adapted for pumping such liquids as cooling compounds, oils, brines, and enamel. The self-priming and anti-clog features embodied in "Fulflo" pumps of past designs, and their free floating impellers, have been incorporated in the new product. It is claimed that with either a central supply-tank system or with individual machine pumps, a constant flow of liquid through the pump is assured, whether delivering only a few drops or a copious flow.

DANLY BLANKING DIE STOP

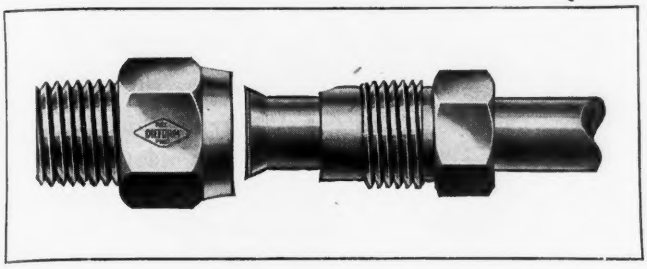
A gage or stop intended for application to blanking dies of almost any construction, whether of the simple, progressive, or compound type, is being introduced to the trade by the Danly Machine Specialties, Inc., 1613 N. Lincoln St., Chicago, Ill. This stop is of simple and compact design. A set-screw on the upper die member strikes a lever to actuate the stop members on the stripper plate. To attach the stop to the die, it is merely necessary to drill three holes and plane or mill a groove, ¼ by 5/16 inch long, to connect two of the holes. The assembly of the stop members to the stripper plate is made after drilling two small holes to receive grooves.



Danly Stop for Application to Simple, Progressive, and Compound Blanking Dies

PARKER TUBING COUPLING

For use with fuel-oil burners and in machinery and other equipment requiring replaceable solderless couplings for soft metal tubing, such as brass and copper, the Parker Appliance Co., Superior Viaduct and Vermont Ave., Cleveland, Ohio, has brought out the "Dieform" coupling here illustrated. This coupling has two nuts, which flange the ends of the tubing being connected, as the nuts are assembled. The tubing is supported in the same manner as in S. A. E.



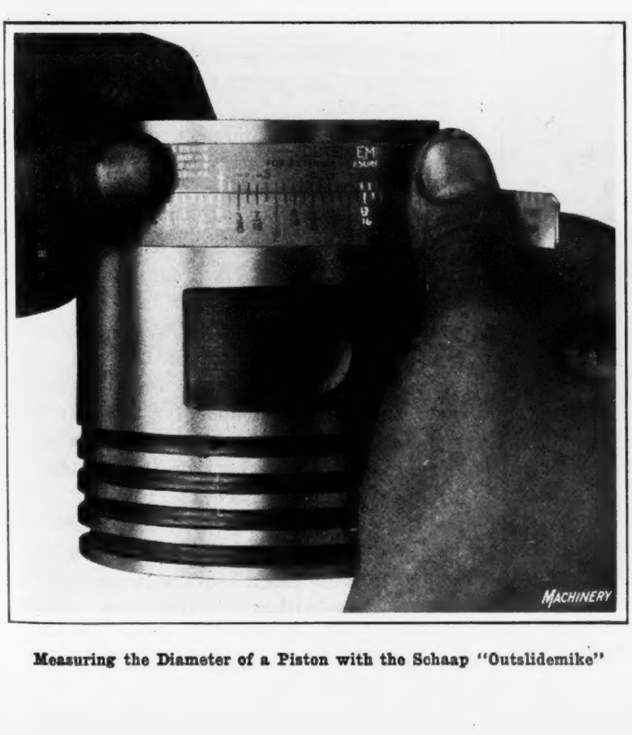
"Dieform" Coupling for Brass and Copper Tubing

couplings. The couplings are made in different sizes to suit ⅛-, 3/16-, ¼-, 5/16-, and ⅜-inch tubing. The different sizes have standard pipe threads, and are interchangeable with other couplings.

SCHAAP "OUTSLIDEMIKE"

A handy instrument or tape intended for measuring the diameter of circular parts, such as automobile pistons, from 2⅝ to 5 1/16 inches, within an accuracy of 0.001 inch, has been brought out by the Schaap Co., 344 Cumberland St., Brooklyn, N. Y. This device is intended to cover the work of the outside micrometer caliper, but instead of giving readings in decimals, it gives direct readings in fractions of an inch to sixteenths, and in thousandths of an inch more or less than a given fraction. For instance, if a piston measured 4.3175 inches by means of the micrometer caliper, the "Outslidemike" would give a reading of 4 5/16 inches plus 0.005 inch. It is particularly intended for use by mechanics who are not familiar with the decimal system. The graduations are spaced about three times farther apart than on micrometers, and so can be easily read.

In use, the device is wrapped around the part, as illustrated, with the end held by the right hand beneath the end pressed down with the left-hand thumb. The diameter is found on the lower band by reading the fractional graduation approximately opposite the zero line of the upper

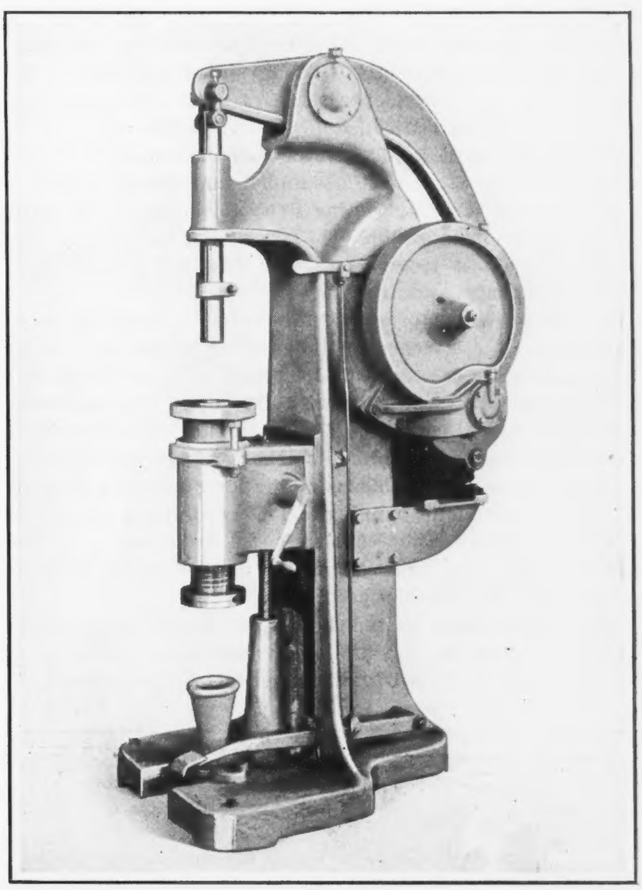


Measuring the Diameter of a Piston with the Schaap "Outslidemike"

band. If the zero mark does not coincide exactly with a graduation, the graduations in the upper band are read in the same manner as a vernier to determine the number of thousandths of an inch that the work is larger or smaller than the fractional dimension nearest to the zero mark. In the illustration the device shows the diameter of the piston to be 4 5/16 inches plus 0.004 inch.

GREENERD CAM-OPERATED MOTOR-DRIVEN ARBOR PRESS

A cam-operated motor-driven No. 24 arbor press intended especially for use in shops where a large number of pieces are held on arbors or mandrels for machining, and where parts are assembled in large quantities by employing arbor presses, has been placed on the market by Edwin E. Bartlett, Nashua, N. H. The end of the ram is bored and threaded to receive special tools. It has a maximum movement of 5



Greenerd Arbor Press, built by Edwin E. Bartlett

inches obtained by means of a cam and rocker arm. This movement may be reduced by means of a clamping collar on the ram that may be set to prevent the complete return of the ram and thus reduce the effective throw of the cam. The cam is operated from an instantaneous Horton clutch, and may be engaged either by hand or foot. A ½-horsepower motor running at 1140 revolutions per minute is used to drive the machine, the gear reduction from the motor to the camshaft being such that the cam revolves at the rate of about 20 revolutions per minute and makes a complete cycle in three seconds. A quick return is provided for the ram.

The knee contains a yielding work surface and is adjustable for height. The yielding abutment is held under tension caused by compressing a coil spring, this tension being adjustable by means of a screw. There is a 2½-inch diameter hole through the abutment. A receiving pocket attached to the base catches arbors, etc., dropping through the knee. The over-all height of this press is 73 inches, and

the distance from the center of the ram to the frame is 9 inches. The weight of the machine complete is approximately 1575 pounds.

LEBLOND HEAVY-DUTY ENGINE LATHES

Thirteen- and fifteen-inch heavy-duty engine lathes of both geared- and cone-head types are being brought out by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Except for the headstock and taper attachment, these lathes are quite similar in design to lathes of other sizes built by the same company. Two types of motor-driven lathes are furnished—a belt-driven machine equipped with either an alternating- or direct-current constant-speed motor, and a gear-driven machine with a direct-current variable-speed motor.

The variable-speed geared motor drive is supplied with automatic controllers which embody a dynamic brake. The motor is mounted on top of the headstock, as illustrated in Fig. 1, the drive being transmitted through a pinion and an intermediate gear to a wide-face gear that replaces the driving pulley. In this construction the first series of gear changes, ordinarily in the headstock, are omitted, the speeds being obtained electrically; and on lathes with beds 6 feet or shorter, the clutch-operating lever is also eliminated, the spindle being controlled by means of the lever on the electric starting box. This lever controls both the forward and reverse rotation of the spindle, and when brought to the "off" position, applies the dynamic brake to bring the spindle to an instant stop. On lathes with beds longer than 6 feet, an apron motor control is supplied instead of an apron mechanical control.

In the belted motor drive, the motor is mounted on an adjustable plate attached to the head leg of the lathe at the rear, and power is transmitted through a belt to the driving pulley. On lathes equipped with this drive, having beds 8 feet and longer, the spindle is started and stopped mechanically from the apron, while with shorter beds, the spindle is started and stopped by means of the lever on the headstock. A 2-horsepower motor running at 1750 revolutions per minute is recommended for the constant-speed drive, and a 2-horsepower motor running at from 740 to 2200 revolutions per minute for the variable-speed drive.

The single-pulley geared headstock developed for these lathes is shown in Fig. 2. It provides nine spindle speed changes ranging from 20 to 350 revolutions per minute, by the manipulation of two levers. The speeds may be readily determined from the direct-reading index-plate on the front of the headstock. All gears are made of steel, the sliding gears being made of a nickel-alloy steel, heat-treated and hardened. The gear teeth are of the stub form, and are rounded to insure easy engagement. The driving pulley is connected to the shaft through a multiple-disk clutch which is operated by a lever on the front of the head. This lever applies a brake when the clutch is released, so as to bring the spindle to an instant stop.

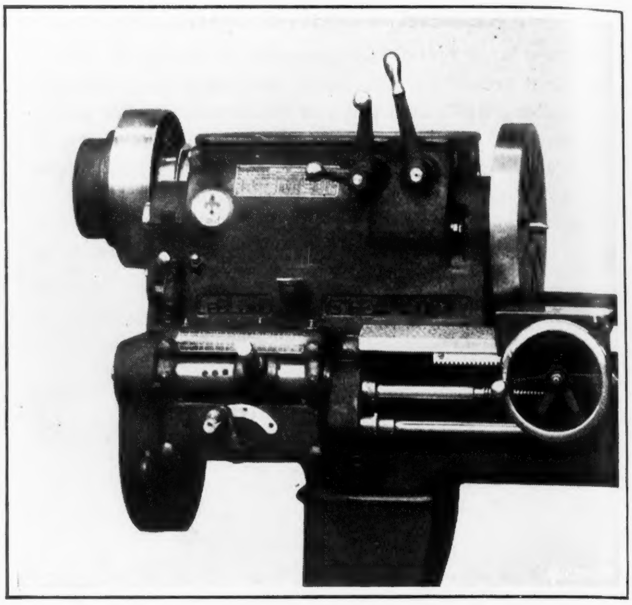


Fig. 2. Single-pulley Drive Geared Headstock which gives Nine Spindle Speeds

Oil is carried by the rotation of the gears to a simple conveyor trough, which may be seen in Fig. 3, and distributed in an abundant stream to the gears and bearings. The spindle bearings and the multiple-disk clutch are also continuously flooded with oil from the same source. The spindle is a 0.50-point hammered crucible-steel forging, and its bearings are made of bronze and lined with babbitt. The front spindle bearing is tapered, and can be adjusted for wear by means of adjusting screws at the front of the headstock.

On the double-friction back-geared lathe, (not illustrated), the back-gear mechanism consists of two cone pinions, two back-gears fitted with friction clutches and mounted on the quill shaft, a face gear and pinion, and a lever used in engaging and disengaging the friction clutches. The friction clutch consists of but three parts, an expanding ring, a taper wedge, and a double taper key. The wedge and key are hardened and ground.

The taper attachment shown in Fig. 4, consists of a bracket bolted and doweled to the back of the carriage for carrying a stationary taper bar on which a swivel guide bar is mounted. The taper bar is dovetailed to the bracket, and is free to slide in it. The attachment can be put into use at any position along the bed by simply clamping a bracket to the shears of the bed. The taper guide bar can be set for turning any desired taper by means of a set-over knob and rack, and two binder studs provide for clamping the guide bar for turning the desired taper. This bar is graduated in sixteenths of an inch per foot, and in degrees. The cross-feed screw is mounted in a sleeve which, in turn, has a bearing in the carriage and in the outboard supporting bracket. In turning tapers, the steel draw-bar seen in the illustration is clamped to the taper shoe

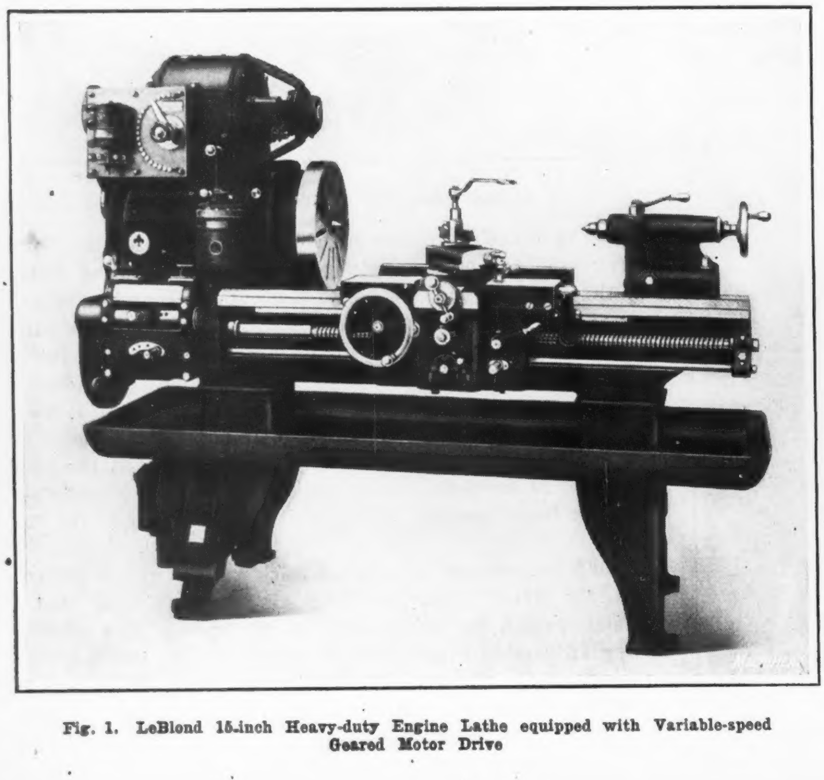


Fig. 1. LeBlond 15-inch Heavy-duty Engine Lathe equipped with Variable-speed Geared Motor Drive

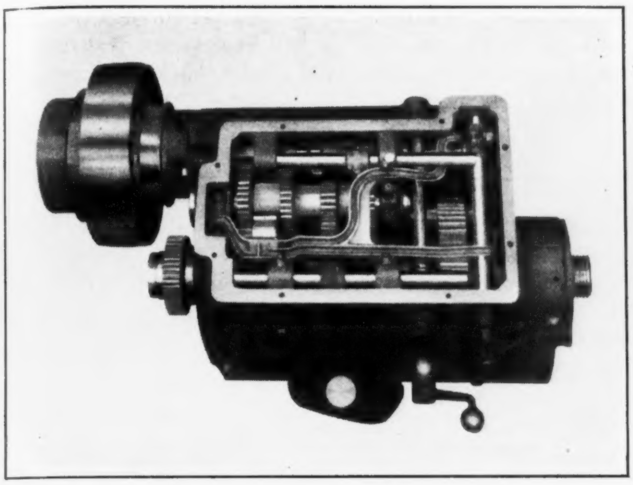


Fig. 3. View showing the Arrangement of the Mechanism in Geared Headstock

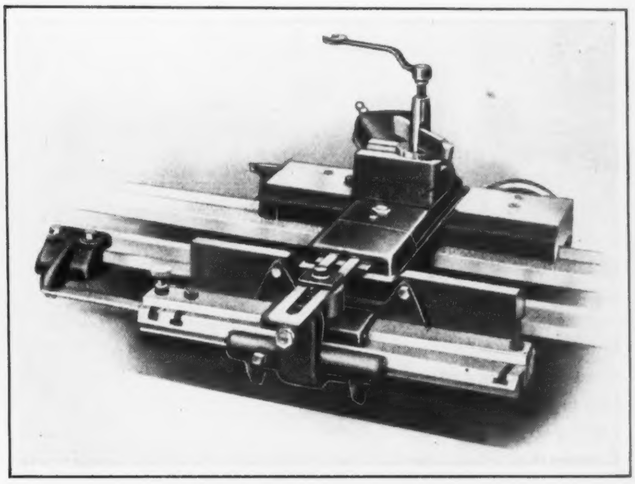


Fig. 4. Construction of the Improved Taper Attachment for LeBlond Lathes

by means of a single bolt, so as to relieve the cross-feed screw and nut of all strain by having the pull taken by the draw-bar and not by the screw. This attachment can be used for turning tapers up to 3 inches included per foot and up to 15 inches in length at one setting.

The apron is equipped with a single positive-jaw clutch for controlling both the longitudinal and transverse feeds. The change from longitudinal to cross feed, or vice versa, is accomplished by means of a sliding gear transmission which is controlled by a knob immediately above the feed clutch. This device is set in a neutral position for threading operations. The bed is provided with the LeBlond improved "compensating vee," which automatically compensates for wear of the carriage and the bed. The range of threads and feeds obtained through the quick-change gear-box covers the usual requirements. A metric quick-change gear-box may be supplied. The compound rest body is set at an angle of 60 degrees with the toolpost T-slot and so there is no interference with the cross-feed screw handle when turning large-diameter work.

Some of the principal specifications of both sizes of lathes are as follows: Distance between centers with a 6-foot bed, 2 feet 7 inches; size of spindle hole, 1 11/32 inches; number of feeds, 32; and range of threads which can be cut, from 3 to 46 per inch. The swing over the carriage on the 13-inch lathe is 9 7/8 inches, and on the 15-inch lathe 11 1/4 inches; and the swing over the shears on the 13-inch lathe is 15 inches, and on the 15-inch lathe 16 1/4 inches.

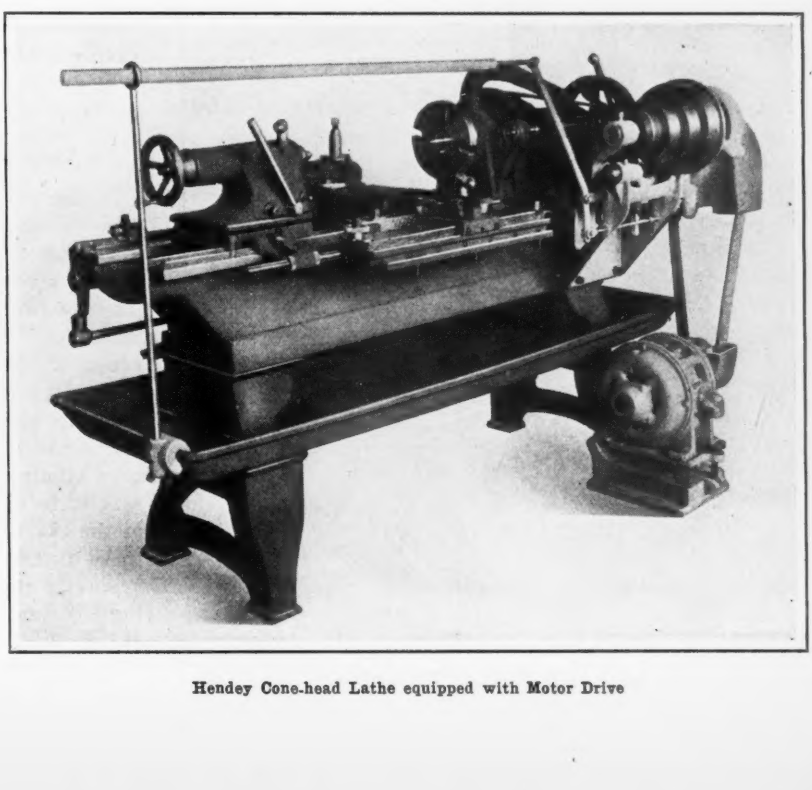
HENDEY MOTOR DRIVE FOR CONE-HEAD LATHES

A compact individual motor drive has been developed by the Hendey Machine Co., Torrington, Conn., for application to the 12-, 14-, 16-, 18-, and 20-inch lathes of both past and present designs built by this company. As will be seen from the illustration, the countershaft unit is mounted on a bracket base clamped to the rear vee of the bed at the headstock end, and is further secured by cap-screws which enter tapped holes near the bottom of the bed. A bracket hinged to the main casting carries the tight and loose pulleys, completely enclosed reduction gearing, countershaft, and cone pulley. The loose pulley runs on ball bearings, and both tight and loose pulleys, as well as the motor pulley, are enclosed by cast-iron guards.

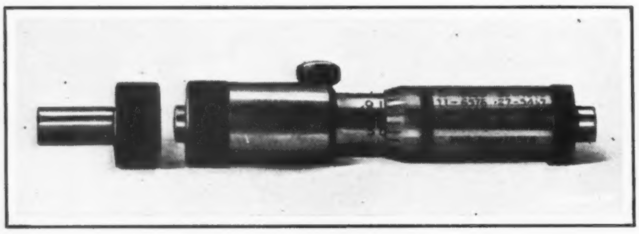
Loosening or tightening of the belt on the cone pulleys may be accomplished by means of quick-operating toggles and a hand-lever, which are employed to move the countershaft toward or away from the lathe spindle. Screw adjustments are also provided for regulating the tension of the belt to compensate for stretch incident to its use. The motor base and its platform are furnished to suit the motor selected, the platform being secured to the base proper by means of a hinged pin at one end and adjustment screws at the other. These furnish a means of keeping the motor belt at the desired tension. The main motor base is bolted to the floor within the area allotted to the lathe. A constant-speed motor of either alternating or direct current, running at about 1200 revolutions per minute is recommended; however, a lower-speed motor or one running up to 1800 revolutions per minute may also be used. Installation of this drive is quickly accomplished, as the preliminary work consists only of drilling and tapping two holes in the bed and, in some cases, slightly dressing a portion of the rear side of the bed to receive the countershaft bracket.

SLOCOMB INSIDE MICROMETER

The particular advantage claimed for a new inside micrometer now being placed on the market by the J. T. Slocomb Co., Providence, R. I., is that it is impossible for this instrument to get out of order unless it is completely disassembled and the adjusting means moved. This means that the instrument would continue to function accurately, even though



Hendey Cone-head Lathe equipped with Motor Drive



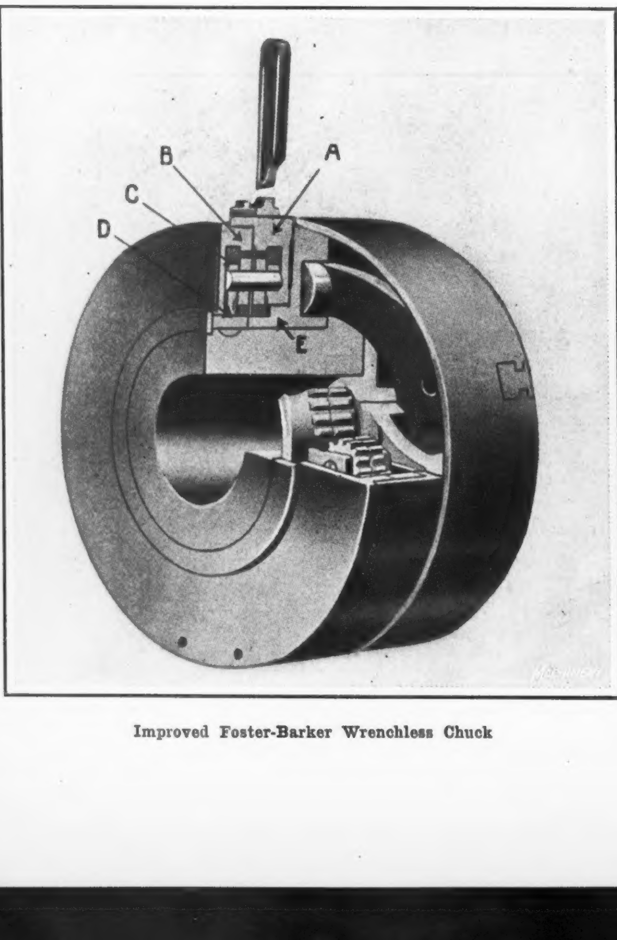
Slocomb Inside Micrometer

a workman were to play with it and perhaps turn the adjustable measuring end. The micrometer is provided with the regular Slocomb adjustment and a tool-steel spindle. It is made in various sizes.

FOSTER-BARKER WRENCHLESS CHUCK

Improvements have recently been made in the mechanism embodied in the Foster-Barker wrenchless chuck manufactured by the Foster Machine Co., Elkhart, Ind., which was described in October, 1920, MACHINERY. This mechanism transmits either an accelerating or a retarding motion to a revolving cam from a hand-lever which does not revolve. Referring to the illustration, internal gears *A* and *B* do not revolve with the chuck, one being fixed to the casing and the other fastened to the hand-lever. Center gear *D* and cam *E* revolve with the chuck, a connection being always maintained with the internal gears through pinions in spider *C*. This member revolves in the same direction as the chuck, but it makes only about one-third the number of revolutions per minute.

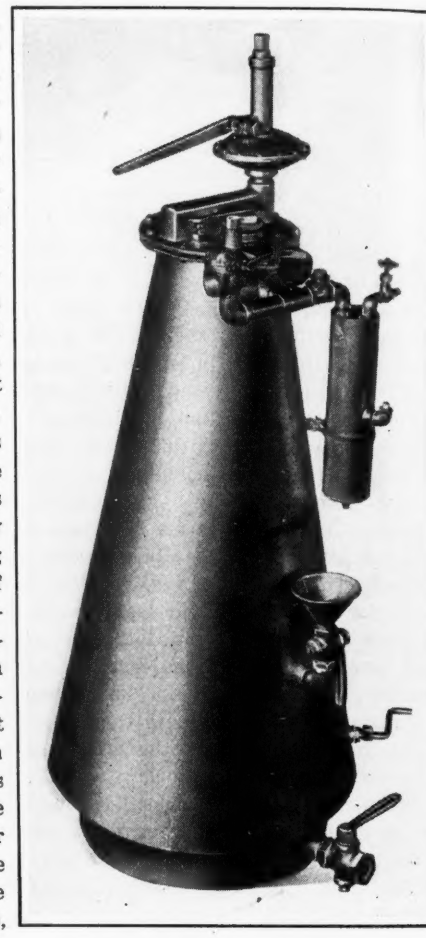
It is evident that if internal gear *A* is advanced relative to gear *B*, cam *E* will be retarded with relation to center gear *D*, and this relationship exists whether the chuck is revolving or stationary. Against the cam surface of part *E* is registered the roller of the arm shown. Consequently, the cam operates the arm, the opposite end of the arm being attached to the jaws and thus opening or closing them as it is moved. The cam of a three-jaw chuck is divided into three equal divisions, and that of a two-jaw chuck into two divisions, both styles having a quick initial rise and the remaining distance slow and powerful. The jaws are thus quickly moved into contact with the work and then forced together with an increased pressure by the slow continued movement of the lever. The movement of the hand-lever for operating the chuck jaws is imparted through the inside set of pinions to the cam. It will be apparent that the jaws may be opened and closed whether the chuck is in motion or at rest.



Improved Foster-Barker Wrenchless Chuck

MILBURN ACETYLENE GENERATOR

A portable acetylene generator for use in oxy-acetylene welding, which is designed to obviate the use of high-pressure cylinders, is made by the Alexander Milburn Co., 1416-1428 W. Baltimore St., Baltimore, Md. This generator has a carbide capacity of thirty pounds, which is equivalent to 150 cubic feet of cylinder gas. The feed is of the double-plunger type, operated by means of a diaphragm control through a lever, having a movement in a six to one ratio. A cast head forms the housing for the lever, and this is made accessible by removing a plug from each side of the housing. A vertical rod on the hopper connects with the lever of the diaphragm control at the top and with two plunger valves at the bottom. One of these plunger valves shuts off the carbide when the pressure is at zero, and the other when high pressure is reached. The generator has a standard blow-off valve with a self-releasing lever. The body of this equipment is made of steel and welded throughout, and the weight of the generator is about 200 pounds.

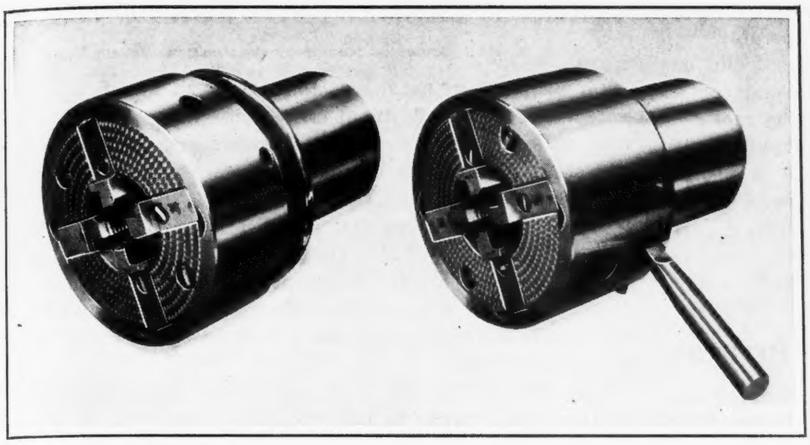


Milburn Acetylene Generator

"NAMCO" HARDENED DIE-HEADS

A line of hardened die-heads made in both the revolving type (as shown at the left in the illustration), and the non-revolving type (as shown at the right), is being placed on the market by the National Acme Co., Cleveland, Ohio. The non-revolving type is intended for use on hand-operated machines. Each type is made in four sizes, to cover a thread range of from 3/16 to 1½ inches. The body and shank of these die-heads are made in one piece, as are also the cam and cup, so as to obtain a simple construction. The bearing of the chasers is directly against the solid cup-cam, and thus eliminates a number of small parts. The cup wall is said to be unusually heavy. Altogether, with the exception of the chasers, only ten parts enter into the construction of these die-heads.

Special alloy steel is used for every working part, including the cup, and all parts are hardened and ground. The chasers are hobbed and lapped, and are ground on the bottom. They fit hardened and ground plates, and are fully supported



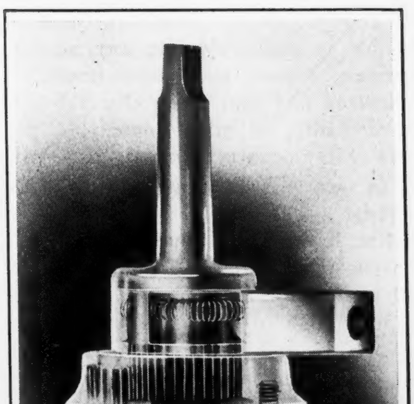
"Namco" Revolving and Non-revolving Types of Die-heads

to insure rigidity while cutting. The chasers project beyond the body of the die-head, so as to permit of threading close to shoulders and to provide freedom from chips. A running test is given each set of chasers. The shank is made either soft or hard, as desired, a hardened plate being supplied for the screw when a soft shank is used. An inside trip can also be furnished.

JARVIS SENSITIVE HIGH-SPEED TAPPING DEVICES

Two sensitive high-speed tapping devices are now being placed on the market by the Geometric Tool Co., New Haven, Conn. These differ from the Jarvis style FD friction type tapping device illustrated in November, 1921, MACHINERY, in that they are equipped with a shock absorber, are particularly sensitive, and their bodies are made of aluminum. Also, the new devices are intended for tapping only up to 3/16-inch holes, whereas the previous style covered a range from 0 to ¼ inch. The chuck spindle is made of tool steel, hardened and ground.

Style OA has a positive ball drive, while style OAN has a cone friction drive. However, both styles are equipped with the shock absorber, which acts on reverse gears. This feature is of great advantage, especially when the spindle is running, for example, at 2000 revolutions per minute, and the chuck runs at 4000 revolutions per minute in reverse. The shock at the instant of the impact would ordinarily be great, and by practically eliminating it, the average life of the taps has been increased. Style OA is intended for work tapped through the piece and style OAN is recommended for tapping blind holes and for tough work. These devices weigh slightly less than two pounds.

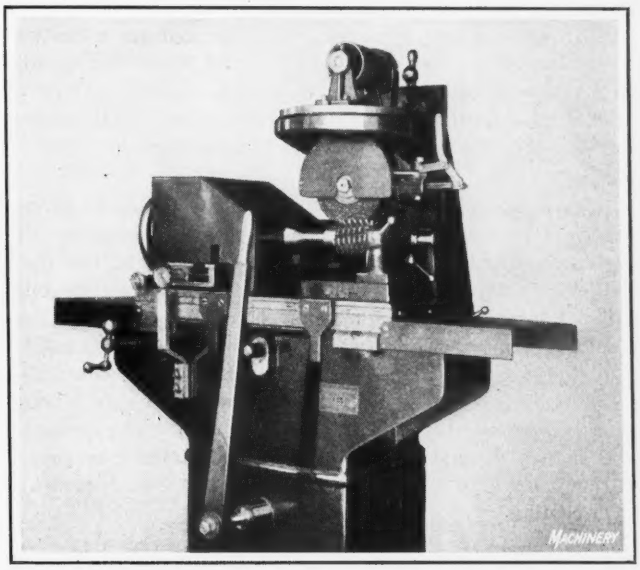


Jarvis High-speed Tapping Device

HARRIS SEMI-AUTOMATIC HOB-GRINDER

A semi-automatic machine intended for grinding gear hobs that have either straight, right- or left-hand helical flutes and that are not over 4 inches in diameter by 5 inches in length, is being placed on the market by the Harris Engineering Co., Bridgeport, Conn. This No. 5 semi-automatic hob-grinding machine, except for the size of work handled, is similar to the larger No. 10 machine described in October MACHINERY. An important improvement has been made in the method of transmitting rotary motion to the work during the travel of the table in order to permit of grinding hobs having right- or left-hand helical flutes. A lever pivoted at the center and having ball bearings at each end is connected to the work-spindle through a steel tape which is wound on a drum. By changing the angle at which this ball-bearing lever operates, a positive helical motion is generated for the work during the travel of the table. The table is carried on ball-bearing rollers.

The index-plates are made of heat-treated chrome-nickel steel; they are accurately cut from a master plate and are double, one plate being used for indexing and the other for escapement. The escapement pawl is provided with an adjustment to take up wear, and because of this design all wear comes on the escapement plate and none on the set employed for indexing. By this arrangement the original accuracy is maintained. The indexing mechanism is semi-automatic, and is operative only at the end of the return stroke, thus preventing any damage which might occur to the grinding wheel or the hob by an accidental indexing in the middle of a stroke. The index-plates are quickly changed.



Harris Semi-automatic Machine for grinding Hobs up to 4 Inches in Diameter and 5 Inches in Length

The wheel-head and column are so designed as to make the center of the wheel swivel on the center line of the table and to obtain a minimum overhang. The wheel-spindle is carried in large bronze bearings of an oil-well construction, is dustproof, and has a device for taking up thrust and wear. It is driven by an open belt, and receives grinding wheels up to 7 inches in diameter. The diamond truing device is built in the head where it is always in position for use, and may be used when the machine is in operation, without disturbing the work.

This machine may be set to grind under-cut hobs or cutters and to give them top rake, as well as to grind them in the ordinary way with radial faces. The feed of the

hob is obtained by rotating it against the wheel by means of a small handwheel, which is turned by the operator's left hand after each complete revolution of the hob. The machine may be furnished with either a countershaft or an individual motor drive. When motor-driven, the motor is mounted on top of the machine on a pedestal supplied with means for taking up belt slack. The machine is usually equipped for dry grinding, but it can also be provided with pumping equipment for wet grinding. All working parts are protected from emery dust.

* * *

NEW MACHINERY AND TOOLS NOTES

Saw Filing Machine: American Saw Filing Machine Co., Boston, Mass. A machine brought out primarily for filing band saws used in cutting soft metals. The machine operates automatically, the saw being fed forward in such a manner that the file advances from tooth to tooth, the same as in filing by hand. The feed is accomplished entirely independently of the teeth, so there is no interruption of the operation in the event that a broken tooth is encountered. The machine is adjustable to receive saws from 1/8 to 2 inches in width, and for filing teeth as fine as 15-point.

Forming Press or Brake: J. M. Robinson Mfg. Co., 3282 Spring Grove Ave., Cincinnati, Ohio. A gap forming press or brake which may also be readily converted into a gang punch. The housings have a gap of 12 1/2 inches from the center of the slide which is a particularly convenient feature in cases where the sheets to be formed are wider than the distance between the housings, and when the metal is formed over dies to such a shape that it can only be removed by sliding from the end. The machine is built in three sizes, having 4 1/2, 5 1/2, and 6 1/2 feet, respectively, between the housings.

Rotary Quenching Tank: W. S. Rockwell Co., 50 Church St., New York City. An automatic rotary quenching tank, designed according to the principle embodied in the Rockwell rotary furnace. It is intended for heat-treating small parts in large quantities, and may be operated directly from a rotary furnace. The parts to be quenched are slid quickly into the submerged end of the quenching tank where they are automatically picked up in small batches by an internal screw, conveyed through the quenching fluid and raised to a cone-shaped discharging spout. The continuous movement of the parts in the circulating fluid are said to insure uniform cooling.

Drop-hammer: Boston Hammer Co., Boston, Mass. A pneumatic gravity drop-hammer, which drops with all its force when the air has been released by operating a lever, and returns to the raised position ready for the next blow. The length of drop is adjustable, and the blow can be regulated from full to very slight, by opening or closing a release air valve. If the air should give out suddenly, an automatic check valve would function to hold up the hammer for several minutes, and then permit it to descend slowly. A safety lever necessitates that the operator use both hands in tripping the hammer. The weight of this machine is about 3600 pounds.

* * *

An ordinary vertical file is recommended by the Business Consultation Bureau of the La Salle Extension University as the simplest means for conveniently filing clippings from magazines. By filing the clippings in folders containing only material of like nature, and arranging the folders alphabetically, it is possible to so arrange the clipping file that any subject can be instantly referred to. If the clippings are small, it is desirable to paste them on standard letter-size sheets, so that they will not be lost among the larger sheets and clippings. When there is a great amount of material filed in this way, the file can be supplemented by a card index which will give cross-references.

TERMS OF PAYMENT FOR FOREIGN SALES

By H. A. NAU, American Machinery Corporation, Madrid, Spain

On page 435 of February MACHINERY, an article appeared entitled "Terms of Payment for Foreign Sales." This article does not seem to agree with the understanding of European and especially Spanish markets that the writer has acquired from many years' experience. Referring especially to Spain, it might be pointed out that every reliable concern in Spain considers it an insult if asked to pay for its purchases when the goods are ready for shipment in New York, and would prefer to buy their machines where the manufacturers or their Spanish representatives will grant them such terms as they may ask.

Referring to that part of the article that deals with credits obtained from banks in the customers' own country, it may be stated that Spanish banks, for example, will not extend any credit whatsoever upon stocks of machines or even real estate, without actually mortgaging them and thereby taking over the title of the owner. The only conditions under which credit can be obtained from the banks is through the personal guarantees of well-known people. The banks require a high percentage of interest for credits secured in this way, and extend credit for ninety days only.

As a result of the war, most of the European countries are entirely impoverished, but Spain is one of the exceptions, and may be considered financially one of the most reliable of the European countries, along with Switzerland, England, Holland, and the Scandinavian countries. For this reason, instead of trying to reduce credits to Spanish customers, American manufacturers ought to do everything in their power to extend greater credit facilities, inasmuch as Spanish currency is sound. A reliable agent should be given the benefit of the utmost that the American machine tool builder can do in this respect.

* * *

INDUSTRIAL RECOVERY ABROAD

It has been the common impression, according to one of the monthy reviews of the Federal Reserve Bank of New York, that this country has been almost the only one that has recovered any business activity since the depression of 1921, and it appears to be commonly believed that there has been little, if any, recovery in the European countries. Figures are not available to make possible any accurate measurement of European conditions, such as are possible in this country, but as pig iron and coal production are basic in the activities of practically all other industries, they reflect closely the status of any country's industrial activity, and the tonnage of ships cleared is a good measure of the movement of foreign trade.

The pig iron production in France, including Alsace-Lorraine, is now within 5 per cent of the pig iron production in France in 1913, and is 40 per cent in excess of the 1921 production. The coal production in France is within 6 per cent of the production in 1913, and is 10 per cent in excess of the 1921 production. The shipping of France is in excess of the pre-war shipping, and has increased by over 20 per cent in the last year. In England, the total measure of activity is less in proportion to pre-war business than in France, but the increase relative to the business in 1921 is greater. For example, in 1922 the pig iron production was nearly double that of 1921. The coal production increased by 50 per cent, and the tonnage of ships cleared, by over 60 per cent, so that, as far as the two leading European countries are concerned, business is improving, even if not at as rapid a rate as in the United States.

* * *

The General Electric Co. has announced the formation of an Employes Securities Corporation which will issue $5,000,000 worth of bonds to be sold to employes. Interest at the rate of 8 per cent will be paid to the purchasers of these bonds as long as they remain in the employ of the company.

PERSONALS

Fred K. Cordes, formerly connected with J. H. Williams & Co., Brooklyn, N. Y., is now associated with the Western Drop Forge Co. of Marion, Ind.

F. W. Davis, for several years connected with the Buffalo plant of J. H. Williams & Co., has become associated with the Western Drop Forge Co. of Marion, Ind., and will have charge of cost accounting.

Harold Prigoff, for the last four years sales manager of the Syracuse Supply Co., Buffalo, N. Y., has resigned to become eastern sales manager for the Gardner Machine Co., with headquarters in New York City.

Carl F. Berger, for ten years assistant manager of the Monarch Machine Tool Co., 209 Oak St., Sidney, Ohio, has been appointed secretary and general manager of the Whipp Machine Tool Co. of the same city.

Harry T. Scott, formerly sales manager of the Detroit Twist Drill Co., has become New England representative of the Whitman & Barnes Mfg. Co., Akron, Ohio, manufacturer of twist drills and reamers. Mr. Scott's headquarters will be in Hartford, Conn.

William W. Schwebs has been appointed general sales manager for William L. Procunier, Chicago, Ill., manufacturer of tapping chucks and attachments. Mr. Schwebs was formerly connected with the Western Electric Co., and the Keller Pneumatic Tool Co.

Henry F. Russell, formerly with the Lumen Bearing Co., and for the last five years sales manager of the iron foundry department of Farrar & Trefts, Inc., Buffalo, has been appointed treasurer and general manager of the Buffalo Smelting Co., Inc., Buffalo, N. Y.

Malcolm Grant, formerly with Black & Decker Mfg. Co., Baltimore, Md., has been appointed eastern district manager for the Rainey Tool Co., Cleveland, Ohio, manufacturer of machine tools, pneumatic drilling and chipping tools, mechanics' hand tools, and special tools.

Charles J. Schmid has been placed in charge of sales in Greater New York and Long Island of the carbon dioxide recorders and other power plant gages made by the Uehling Instrument Co., Paterson, N. J. Mr. Schmid was formerly in charge of the Boston office. His headquarters will be in Paterson temporarily.

S. S. MacIntosh, formerly associated with Cyril J. Bath, machinery dealer of Cleveland, Ohio, has recently become connected with the Maxwell Tool & Supply Co., 4500 Euclid Ave., Cleveland, Ohio, dealer in machinery, cutters, and belting. Mr. MacIntosh has had many years of experience in selling new and used machinery.

Paul A. Collins, formerly Washington representative of the Automatic Electric Co., has been appointed assistant manager of the P. A. X. Department of the North Electric Mfg. Co., Galion, Ohio, manufacturer of private automatic exchanges for inter-office communication and machine switching systems for city telephone exchanges.

Huber L. Morrison has joined the organization of the Greenfield Tap & Die Corporation, Greenfield, Mass., and will represent that company in Connecticut and Rhode Island. Mr. Morrison has been associated with the small tool industry for quite a number of years, and is well posted on all aspects of small tool manufacturing and selling.

Edward C. Waldvogel, general manager of the Yale & Towne Mfg. Co., Stamford, Conn., was elected a vice-president, at a recent meeting of the board of directors. His title will be vice-president in charge of sales. Mr. Waldvogel has been associated with this organization for the last eighteen years, starting as a traveling salesman in 1905.

M. D. Galbreath, formerly manager of sales of the McCoy-Brandt Machinery Co., has become associated with J. C. Marr of the J. C. Marr Machinery Co., and after April 1 will conduct business under the firm name of Marr-Galbreath Machinery Co., with office and warehouse at 127-129 Water St., Pittsburg, Pa. The company will deal in new and used machinery.

Richards & Geier, 277 Broadway, New York City, patent and trademark attorneys, have made the following additions to their staff: Joseph Farley, formerly an assistant examiner in the United States Patent Office and a member of the D. C. Supreme Court and Court of Appeals Bar; Henry Ruhl, trademark specialist; and Fritz Ziegler, Jr., registered patent attorney specializing in patent and unfair competition litigation.

C. J. Mundo has been placed in charge of the Pittsburg office of the Monitor Controller Co., Baltimore, Md., manufacturer of automatic motor controls for all kinds of motor-driven machinery. The Pittsburg office is located in the Union Arcade Bldg. G. H. Armstrong, formerly in charge of the Pittsburg office, is now located in Cincinnati at 307 First National Bank Bldg. Mr. Armstrong's territory will comprise southwestern Ohio, southern Indiana, and Kentucky.

B. Olney Hough, for many years editor of the "American Exporter," has established a business of his own as export counsellor, consultant, and adviser to banks, exporters, and manufacturers. The firm will be known as B. Olney Hough, Inc., and will be located at 17 Battery Place, New York City. Mr. Hough will continue to serve the "American Exporter" as export and technical adviser and writer, with the title of contributing editor. He has had a wide experience in the export field, and is the author of several books on exporting, one of which is entitled "Practical Exporting."

OBITUARIES

COLUMBUS K. LASSITER

Columbus K. Lassiter, president of the Consolidated Machine Tool Corporation of America, was stricken with heart failure, on the evening of March 3, as he was driving his automobile on Broadway, near 72nd St., New York City. He died shortly after, while being taken to the Roosevelt Hospital.

Mr. Lassiter was born in 1866 in Roanoke, Va. He reached a high position in the mechanical field by sheer perseverance and constant application to work. He did not have the foundation of a college education to build upon, because the death of his father, when he was thirteen years old, necessitated his leaving school to earn a livelihood. He was then apprenticed to a blacksmith and during his apprenticeship studied evenings. At that time he already evinced a keen interest in mechanical appliances. Upon completion of his apprenticeship, he obtained a position with a flour milling concern, and at the age of nineteen was managing the business. When twenty years old, he bought out a bakery and confectionery establishment. This enterprise was successful, but on account of his greater interest in machinery, he sold the business and in 1892 entered the employ of the American Locomotive Works at Richmond, Va., as a timekeeper. In ten years he had advanced to the position of vice-president in charge of production, and retained this position until 1922, when he resigned to become one of the organizers of the Consolidated Machine Tool Corporation of America.

At the time of his death, Mr. Lassiter was interested in several industrial and financial companies in addition to the one of which he was the head. He owned the controlling interest in the Baush Machine Tool Co., Springfield, Mass., at one time. During his connection with the American Locomotive Works he took out a considerable number of patents, principally on staybolt cutting machines of both the horizontal and vertical types. When the war broke out, he successfully undertook the first contract to manufacture shells for the Allies. At one time he had 30,000 employes under his supervision in the American and Canadian plants of the company.

Mr. Lassiter is survived by his wife, two daughters, and a son, Robert R., who is secretary of the Consolidated Machine Tool Corporation of America.

Alton N. Bates, vice-president and general manager of the Erie Foundry Co., Erie, Pa., died February 17.

Howard M. Wilson, president of the Taylor Wilson Mfg. Co., Pittsburg, Pa., died suddenly on February 16, aged sixty-one years.

TRADE NOTES

F. P. Screw Co., Cleveland, Ohio, has changed its firm name to the Cleveland Cap Screw Co. This change is in name only, the personnel remaining the same.

Hjorth Lathe & Tool Co., manufacturer of precision bench lathes and machine and machinist's tools, announces that it is now located at its permanent address, 10 Tremont St., Boston, Mass.

E. A. Harper Tool & Supply Co. has combined with the Aborn Steel Co., and has incorporated under the name of the Aborn-Harper Steel & Engineering Corporation, with offices at 22-24 Clarke St., New York City. E. A. Harper is president and directing head of the new corporation.

Timken Roller Bearing Co., Canton, Ohio, is making provision for a considerable increase in the production of Timken tapered roller bearings at both the Canton and Columbus plants. Extensive additions to the equipment are being made at both factories, and a large modern factory building is in the process of construction at the Canton plant.

Gibb Instrument Co., Bay City, Mich., manufacturer of electric welding equipment, has increased its capital stock from $75,000 to $175,000. The company announces the opening of a sales office in the General Motors Bldg., Detroit, in charge of F. M. Luchs, formerly chief engineer, and also in Cleveland, Ohio, at 2104 E. Superior Ave., in charge of W. O. Little.

Link-Belt Co. of Philadelphia, Chicago, and Indianapolis, announces that the price of its portable belt conveyor known as the "Cub" has been reduced more than 16 per cent. Owing to the large volume of orders on hand, the "Cub" loader was put on a quantity production basis, resulting in a large saving in the cost of manufacture, and thus making possible a reduction in price.

Stewart Mfg. Corporation, manufacturer of die-molded castings and bronze bearing metal, announces that the office of its Ohio representative, E. P. Grismer, has been removed from 326 Caxton Bldg., Cleveland, Ohio, to 1982 E. 66th St. A complete stock of semi-finished cored and solid bars of Stewart bronze bearing metal will be carried at that office for immediate delivery.

Shields Machine Co., 1729 Doan Ave., Cleveland, Ohio, has been organized to manufacture a line of small tools, as well as screw machine and automotive parts. The president of the concern is Carl Shields, formerly of the Shields Cutter Co. and the Cleveland Milling Machine Co.; vice-president and general manager, L. H. Mesker; and secretary-treasurer and factory manager, S. S. Shields.

Spartan Saw Works, Springfield, Mass., manufacturer of hacksaw blades, reports that its rapidly increasing business has made it necessary to erect a new factory, which is located at Wason and Fisk Aves., in Brightwood, Mass. The new building is a one-story brick and steel structure of modern mill type, conveniently arranged, and providing for expansion as the business increases.

Joseph T. Ryerson & Son, Inc., 16th and Rockwell Sts., Chicago, Ill., have purchased the plant, stock, and good will of the Cincinnati Iron & Steel Co., Cincinnati, Ohio. Lewis E. Skinner, who has been connected with Joseph T. Ryerson & Son, Inc., for eighteen years, has charge of the plant. He will be assisted by C. A. Parnell, former assistant to Arthur Allshul at the Ryerson Buffalo plant.

Production Engineering Corporation, Canastota, N. Y., has been incorporated to take over the business of the Marvin & Casler Co. of Canastota. The corporation will continue to manufacture and sell the Casler tools, including offset boring heads, drill chucks, non-floating reamer holders, planer jacks, planer blocks, and T-slot nuts. The new company is particularly equipped for designing and building special machinery and tools.

Charter Gas Engine Co., Sterling, Ill., has purchased the entire Mietz (also known as Mietz & Weiss) oil engine business heretofore carried on at 128 Mott St. and 430 E. 19th St., New York City, by the August Mietz Corporation and the Reliance Oil Engine Corporation. The Charter Gas Engine Co. is now moving from New York City to its plant at Sterling, Ill., all the physical assets comprising the Mietz engines, meanwhile filling repair orders from New York.

Hydraulic Press Mfg. Co., Mount Gilead, Ohio, manufacturer of high-pressure hydraulic presses, pumps, valves, accumulators, and intensifiers, has recently increased its capitalization from $260,000 to $1,200,000, and is contemplating making extensions and changes in its equipment and buildings. The contemplated extensions consist of a new office building; an extension to the erecting shop, wood, and pattern department; and the addition of a number of new machines to the machine shop and pattern department.

Foster Machine Co., Elkhart, Ind., manufacturer of turret lathes, screw machines, and H. & M. thread millers, announces that at a regular meeting of the board of directors held on February 12, Oskar Kylin was elected vice-president of the company. Mr. Kylin, who is primarily responsible for the design of the new line of Foster screw machines and turret lathes brought out and perfected during the last six years, will continue in immediate charge of sales and engineering. The Syracuse Supply Co., Syracuse, N. Y., has been appointed exclusive agent for the products of the company.

Triplex Machine Tool Corporation, manufacturer of the "Triplex" combination bench lathe, milling and drilling machine, has moved its office from 18 E. 41st St. to 50 Church St., Hudson Terminal Bldg., New York City. At the new address the corporation will also act as dealer in machine tools, small tools and supplies, and has made arrangements for representing several concerns in the New York and New Jersey districts. This company was awarded the Gold Medal at the international exposition of inventions recently held in the Grand Central Palace, for its combination bench lathe, milling and drilling machine, which was there exhibited.

American Tool & Mfg. Works, 652 W. Lake St., Chicago, Ill., is a new concern engaged in the design and manufacture of special machinery, dies, jigs and fixtures, and screw machine and punch press products. A. B. Cochrane, president of the new concern, purchased the plant and equipment of the Screw Machine Products Corporation, the Standard Clutch Control Co., and W. I. Denny. Mr. Cochrane was formerly district sales manager for the Steel & Tube Co. of America and the Mark Mfg. Co. Robert Hofstetter, formerly engineer with the Illinois Tool Works of Chicago and the Nash Motors Co. of Kenosha, Wis., is manager.

Uehling Instrument Co., Paterson, N. J., has appointed Mitsui & Co. its exclusive representatives in Japan and China for the sale of Uehling carbon dioxide recording equipment and other power plant instruments and gages. The main office of Mitsui & Co. is located in Tokio, Japan, and the New York branch office of the company is at 65 Broadway. The Uehling Instrument Co. has also appointed two new agents in the West and Middle West. John E. Arnold, 15½ S. Fourth St., Tulsa, Okla., will have the territory covered by the state of Oklahoma, and H. R. N. Johnson, 917-A Marquette Ave., Minneapolis, Minn., will have the territory of Minnesota, North Dakota, and South Dakota.

Precision & Thread Grinder Mfg. Co., 1 S. 21st St., Philadelphia, Pa., manufacturer of multi-graduated precision grinders, precision thread lead variators and gage blocks, and permanent alignment wheel truing heads, announces the following appointments as foreign representatives: Toronto and Vancouver, Canada, The A. R. Williams Machinery Co., Ltd.; Montreal, Canada, Williams & Wilson, Ltd.; France, Belgium, Switzerland, Italy, and Spain, Allied Machinery Co. of America; Norway, Sweden, and Denmark, V. Lowener; Japan, Andrews & George Co.; Petrograd and Moscow, Russia, M. Mett Engineering Co.; Holland and Dutch East Indies, R. S. Stokvis & Sons; Berlin, Germany, Bohm & Bormann; Melbourne, Australia, Bevan & Edwards.

Wells Corporation, Greenfield, Mass., has been formed as a holding company in which are consolidated the Frank O. Wells Co., Inc., Greenfield, Mass., the American Tap & Die Co., Greenfield, Mass., and the Williamsburg Mfg. Co., Williamsburg, Mass. The joint capital in this merger is well in excess of $1,000,000. The Frank O. Wells Co., Inc., manufactures thread cutting tools, reamers, counterbores, broaches, broaching machines, and tap and drill grinding machines. F. O. Wells, president of the company, was one of the original founders of the firm of Wells Bros., tap and die manufacturers, started in 1876. In 1912 Mr. Wells organized the Greenfield Tap & Die Corporation, of which he was president up to the time of his resignation in 1919. Since that time he has been engaged in development work in the tap and die field. Mr. Wells will be president and consulting engineer of the new consolidated company. L. E. Peck, who has been general manager of the Frank O. Wells Co., Inc., will be vice-president and general manager of the new company. A. B. Allen, of the American Tap & Die Co., manufacturer of a line of standard screw cutting tools as well as of butchers' cutlery and supplies, will be secretary and treasurer of the consolidation. Mr. Allen was formerly cashier of the First National Bank of Greenfield. The Williamsburg Mfg. Co. manufactures a line of screwdrivers, iron levels, and hacksaw and butcher saw frames. David B. Miller, of the Frank O. Wells Co., Inc., will continue in his present capacity, as will also Herbert J. Smith, who will continue as the superintendent of the American Tap & Die Division of the corporation. No changes in the several organizations are planned.